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HESCOMP. THE HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM--ETC(U)
OCT 79 S J DAVIS, H ROSENSTEIN, K A STANZIONE N62269-79-C-0217
UNCLASSIFIED D210-10699-2-REV-2.   NADC-78265-60   NL

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26 November 1979
8-1162-5912

Naval Air Development Center
Warminster, PA 18974

Attention: Code 6051

Subject: Contract N62269-79-C-0217 - Improved Helicopter Sizing and Performance Computer Program (HESCOMP); HESCOMP Users Manual.

Enclosure: (1) HESCOMP Software (1 copy)

(2) HESCOMP Users Manual (5 copies)

Gentlemen:

1. In accordance with Data Sequence Items A002 and A003 of the Contract Data Requirements List, submitted as Enclosure (1) is the HESCOMP Software which includes one (1) IBM Magnetic Tape and one (1) set of sample cases in the form of IBM punched card inputs and line printer output and submitted as Enclosure (2) is the HESCOMP Users Manual.

2. Upon completion of the one-day oral review to be conducted at NADC on 6 December 1979, all direct activity required under the subject contract will

have been completed and administrative close-out action will be initiated necessary to preparation and submittal of the final invoice.

Very truly yours,

S. P. Laskus
Manager
R & D Contracts

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HESCOMP
USER'S MANUAL

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HESCOMP is a helicopter sizing and performance computer program very similar in format and operation to VASCOMP II, the V/STOL Aircraft Sizing and Performance Computer Program. The program's purpose is to provide the means for rapidly developing helicopter sizing and mission performance data. The program can be used to define design requirements, such as weight breakdown, required propulsive power, and physical dimensions of aircraft which are over

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cont

designed to meet specified mission requirements. It is also useful in sensitivity studies involving both design trade-offs and performance trade-offs. HESCOMP

The program has two primary independent applications, a third which is a combination of the first two, and a fourth option used for obtaining aircraft weight only. It may be used for ~~the~~ sizing ~~of~~ helicopters for which the type of aircraft and the mission profile are specified. Alternatively, it may be used for mission calculations for aircraft for which sizing details (gross weight, fuel available, engine power and fuel consumption, etc.) are known. As a combination of these two capabilities, ~~the program~~ it may be used to first size a helicopter for a given mission and then calculate the off-design point performance for other missions. It

The program has been written ~~in a manner~~ to make it directly applicable to sensitivity studies to determine the effect of variations in weight, drag, engine characteristics, etc.

The program contains size trends equations which reflect the variation of helicopter dimensions with gross weight, detailed statistical weight trends equations, a routine for sizing of engines to match airframe requirements, a comprehensive library of engine cycle data, a library of rotor cycle data, and a variety of optional procedures for calculating rotor and propeller (cruise only) performance.

The program can be used to study any single, tandem, or coaxial pure, winged, compound, or auxiliary propulsion helicopter.

USER'S MANUAL FOR HESCOMP
THE HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM

Developed under
Contract No. NAS2-6107 (Study of the Methodology for Evaluation of an Interurban and Intraurban V/STOL Transportation System)

Revised under
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and N62269-79-C-0217

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FOREWORD

HESCOMP, the Helicopter Sizing and Performance Computer Program, provides helicopter designers with the same capability for sizing and performance calculations that VASCOMP II provides for fixed-wing aircraft designers.

Since in time the program will change to reflect new thinking and grow to include more sophisticated methods of simulating advanced helicopters, this User's Manual is loose-leaf bound to facilitate updating of the program.

Inquiries regarding the program should be directed to the authors.

CONTENTS

Page

ILLUSTRATIONS

Figure		Page
4-62	PARA Function, Flow Chart	4-339
4-63	TABLE Function, Flow Chart	4-341
4-64	TRIV Function, Flow Chart	4-344
4-65	XLINT Function, Flow Chart	4-350
4-66	XLKUP Function, Flow Chart	4-352
4-67	XIBIV Function, Flow Chart	4-355
7-1	Design MSN - Sample Case No. 1	7-7
7-2	Design MSN - Sample Case No. 2	7-67
7-3	Design MSN - Sample Case No. 3	7-116
7-4	Design MSN - Sample Case No. 4	7-192
7-5	Design MSN - Sample Case No. 5	7-259

TABLES

NOTE

Section 5.3 contains a definition of program input variables and indicators; section 6.2 lists the major diagnostic error printouts and describes their probable cause. For ease of reference, these sections are printed on blue and green paper, respectively.

1.0 INTRODUCTION

1.1 BACKGROUND

HESCOMP is a helicopter sizing and performance computer program very similar in format and operation to VASCOMP II, the V/STOL Aircraft Sizing and Performance Computer Program, described in Reference 1. This similarity is dictated by the requirement to obtain compatibility in both usage and results when using HESCOMP and VASCOMP II in helicopter-V/STOL aircraft comparative design studies. The program's purpose is to rapidly provide helicopter sizing and mission performance data. The program can be used to define design requirements, such as weight breakdown, required propulsive power, and physical dimensions of aircraft which are designed to meet specified mission requirements. It is also useful in sensitivity studies involving both design trade-offs and performance trade-offs.

During formulation of the program, the following guidelines have been followed:

1. The program should maintain generality and flexibility - A program of this type must be comprehensive and flexible in order to permit an accurate simulation of many types of helicopter configurations. It must be capable of approximating the design process involved in layout and sizing of a wide variety of helicopters and synthesizing the performance of these aircraft.

2. The program should be easy to use - In order to minimize hand computation of input data, the input to the program primarily consists of a series of single point values specifying, for example, main rotor disc loading, solidity, twist, aspect ratio, taper ratio, etc. of the wing, tail, and rotor pylons (where applicable), the geometry of the fuselage, the type of propulsion system, a description of the mission profile, and weights of fixed equipment, fixed useful load and payload. Where necessary to adequately describe certain functional relationships, the input is in tabular form. However, since preparation of data for tabular input is generally more cumbersome and time consuming, this form of input has been kept to a minimum.

3. The program should minimize computation time - In order to minimize computation time, the program makes ample use of optional computation paths. To eliminate large quantities of null arithmetic, it avoids calculations which do not apply to the particular aircraft being studied. This is accomplished by means of a series of input indicators that specify the calculations to be performed.

4. <u>The program should be well balanced</u> - The program should not be extremely sophisticated in one detail and yet extremely simple in another. To offset the possibility of this occurrence, great care has been taken to examine methods used to describe the helicoper and its operation.

5. <u>The program should be compatible with VASCOMP II</u> - In order to insure program compatibility, care has been exercised in planning the input/output format. The input sheets are similar (and in a few cases - identical) to those of VASCOMP II. The output format is the same except for the additions of those output quantities peculiar to helicopter performance. Further, this User's Manual is identical in format to the VASCOMP II User's Manual. In addition, HESCOMP utilizes (unchanged) the engine cycle library, propeller tables, and propeller short form performance method developed for VASCOMP II.

1.2 APPLICATION

The program has two primary independent applications, a third which is a combination of the first two, and a fourth option used for obtaining aircraft weight only. It may be used for the sizing of helicopters for which the type of aircraft and the mission profile are specified. Alternatively, it may be used for mission calculations for aircraft for which sizing details (gross weight, fuel available, engine power and fuel comsumption, etc.) are known. As a combination of these two capabilities, the program may be used to first size a helicopter for a given mission and then calculate the off-design point performance for other missions. The option of calculation to be used is specified to the program by means of an input "option indicator."

The program has been written in a manner to make it directly applicable to sensitivity studies to determine the effect of variations in weight, drag, engine characteristics, etc. This is accomplished by use of incremental multiplicative and additive factors applied to the gross weight, component drag and fuel required equations. For the most part, the multiplicative factors are nominally equal to unity and the additive factors are nominally equal to zero. However, to determine the effect, for example, of a 10 percent increase in drive system weight, the appropriate multiplicative factor can be set to 1.10 and the sizing program rerun.

The program contains size trends equations which reflect the variation of helicopter dimensions with gross weight, detailed statistical weight trends equations, a routine for sizing of engines to match airframe requirements, a comprehensive library of engine cycle data, a library of rotor cycle data, and a variety of optional procedures for calculating rotor and propeller (cruise only) performance.

The program can be used to study any single, tandem, or coaxial pure, winged, compound, or auxiliary propulsion helicopter (see Table 1-1).

TABLE 1-1. HELICOPTER CONFIGURATIONS WHICH MAY BE STUDIED USING HESCOMP.

Helicopter Type (Both Single & Tandem Rotor) \ Additional Lift/Propulsion System Components Which Must be Added to "Pure" Conf.	Wing	Propeller for Auxiliary Propulsion	Auxiliary Independent Engines	Type of Auxiliary Independent Engines		
				T/Shaft	T/Fan	T/Jet
Pure Helicopter						
Winged Helicopter	X					
Compound Helicopter						
(1) Coupled (prim. engines drive auxiliary propulsion system)	X	X				
(2) Auxiliary independent propulsion system						
(a) T/Shaft engine	X	X	X	X		
(b) T/Fan engine	X		X		X	
(c) T/Jet engine	X		X			X
Auxiliary Propulsion Helicopter						
(1) Coupled (prim. engines drive auxiliary propulsion system)		X				
(2) Auxiliary independent propulsion system						
(a) T/Shaft engine		X	X	X		
(b) T/Fan engine			X		X	
(c) T/Jet engine			X			X
Coaxial Rotor Helicopter						
(1) Coupled (prim. engines drive auxiliary propulsion system)		X				
(2) Auxiliary independent propulsion system						
(a) T/Shaft engine		X	X	X		
(b) T/Fan engine			X		X	
(c) T/Jet engine			X			X

2.0 SPECIFICATION OF HELICOPTER CHARACTERISTICS

Specification of aircraft characteristics to the program is made in a variety of ways: through use of input indicators which specify the types of calculations to be made; through use of weights factors and constants; aerodynamics data; propulsion information; and mostly through use of nondimensional geometric information.

2.1 HELICOPTER GEOMETRY

It is assumed that a typical sizing analysis starts with known payload characteristics, both in terms of payload weight and volume requirements. The volume requirements are usually reflected in length, height, and width of the constant diameter (cabin) section of the aircraft. Adding a nose and tail section of reasonable fineness ratio onto the cabin sections would complete the fuselage geometry if this were an airplane (as sized by VASCOMP II). In a helicopter, however, additional geometric characteristics must be determined before the external fuselage dimensions are completely defined.

For example, in the case of the single rotor helicopter, the total fuselage length (in addition to the nose, tail, and constant diameter sections) includes the tail boom, the length of which, in turn, is established by the tail rotor diameter and the need to maintain a reasonable gap between the main and tail rotor discs. Additionally, the tail boom length itself is affected by the relative position of the main rotor on the fuselage. Vertical tail geometry is determined both by dimensional constraints and the need to fulfill directional stability requirements (e.g., sufficient vertical tail area to counteract main rotor torque in the event of tail rotor loss). So, although the basic cabin internal dimensions are fixed, the external overall dimensions can vary widely, depending on how conflicting requirements are resolved.

In the case of the tandem rotor helicopter, not even the internal cabin dimensions are necessarily constant. For example, the need to require a certain level of external configuration compactness (by specifying a high overlap/diameter ratio) can result in overall fuselage dimensions which directly conflict with internal volume requirements.

Wing geometry may be dictated by maneuver "g" requirements, a specified wing loading or aspect ratio, or even propeller tip/fuselage clearance (in the case of a compound helicopter with wing-mounted propellers).

Primary and auxiliary independent engine nacelle size is set

by the type of engine and its size (which, in turn, is dictated by power requirements).

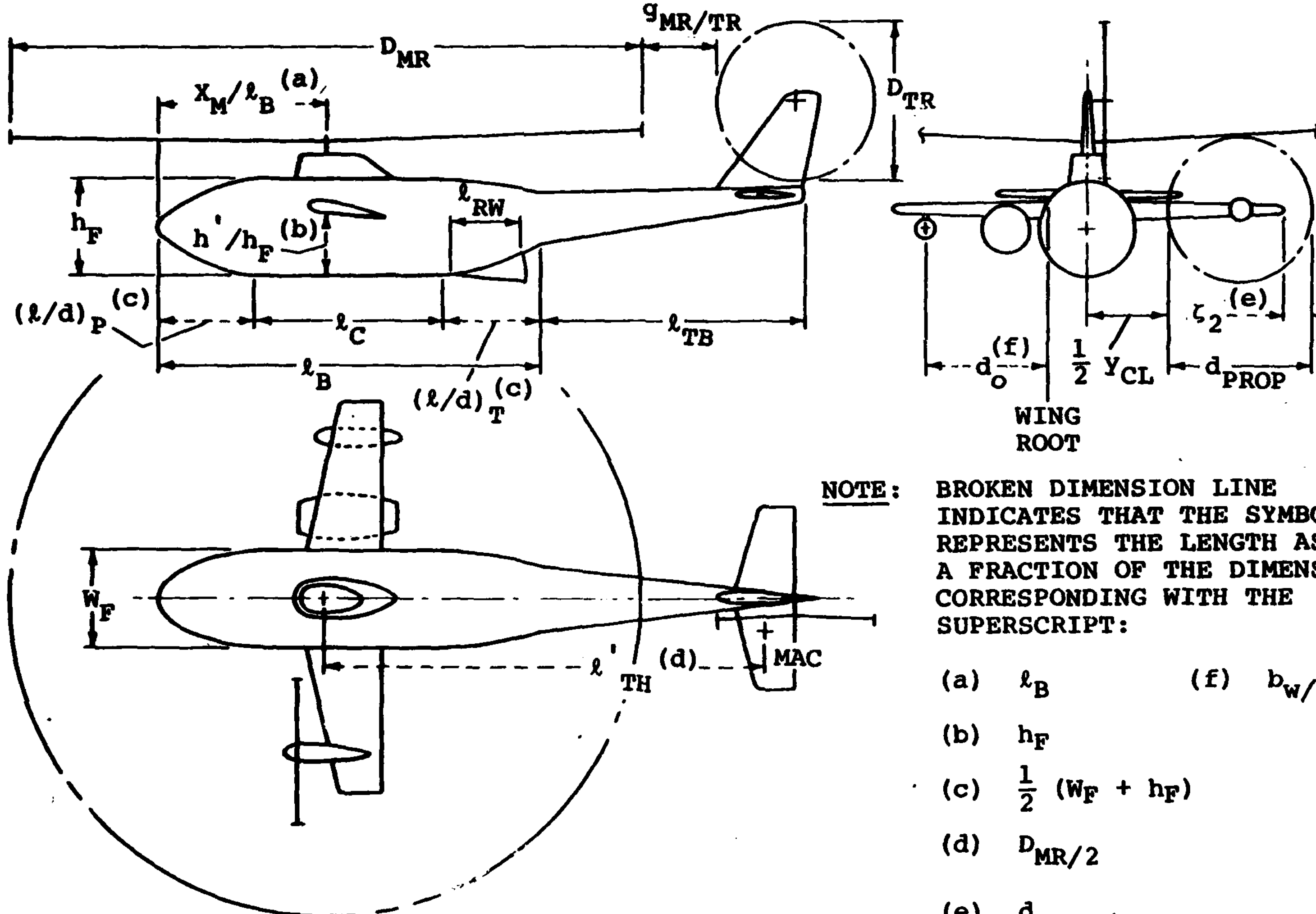
Figures 2-1 and 2-2 of hybrid single and tandem rotor helicopter configurations illustrate the type of information concerning the helicopter geometry which may be required of the user. Tables 2-1 and 2-2 illustrate typical values of selected geometric characteristics for various aircraft. A complete list of input geometric variables is included in Section 5.3.1.

2.2 PROPULSION SYSTEM

This program permits the use of either a single, primary propulsion system or a combination of a primary system and an auxiliary independent propulsion system. For the primary system, turboshaft cycles are always used. For the auxiliary independent system, either turboshaft, turbofan, or turbojet cycles may be used. The program includes the applicable cycles (shown in Table 2-3) from the standard library of eighty-one different generalized engine cycles developed for the VASCOMP II program. The user of the program may either select the desired engine cycle(s) from the standard library or input the characteristics of any arbitrary engine cycle he may choose.

The library engines are unrestricted in performance over their operating system range (dictated by power setting limits). However, the user, at his discretion, may include limits on engine operation by setting maximum values of fuel flow, torque, or gas generator or power turbine shaft rpm. In addition, nonlinear scaling effects of real engines may be included by input of Reynolds number-based correction factors. Degradation in performance of turboshaft engines operating at nonoptimum power turbine speed will be calculated by the program at the option of the user. The library engine cycles may thus be used with no additional input; or, by appropriate additional input, may be made to include the effects of multiple operating restrictions and other factors characteristic of real engine cycles.

During a sizing calculation, the engine cycles may be "scaled" or fixed in size. That is, if the user desires, the program will calculate the engine size required to meet the mission requirements; or, alternatively, he may input engines of specified size. In the case of helicopters employing multiple propulsion systems, the primary system may be sized to provide power to the main rotor(s) for producing lift and part of the total propulsive thrust required; and the auxiliary independent system will be sized to provide the remaining propulsive thrust or power.



NOTE: BROKEN DIMENSION LINE INDICATES THAT THE SYMBOL REPRESENTS THE LENGTH AS A FRACTION OF THE DIMENSION CORRESPONDING WITH THE SUPERSCRIPT:

(a) ℓ_B

(b) h_F

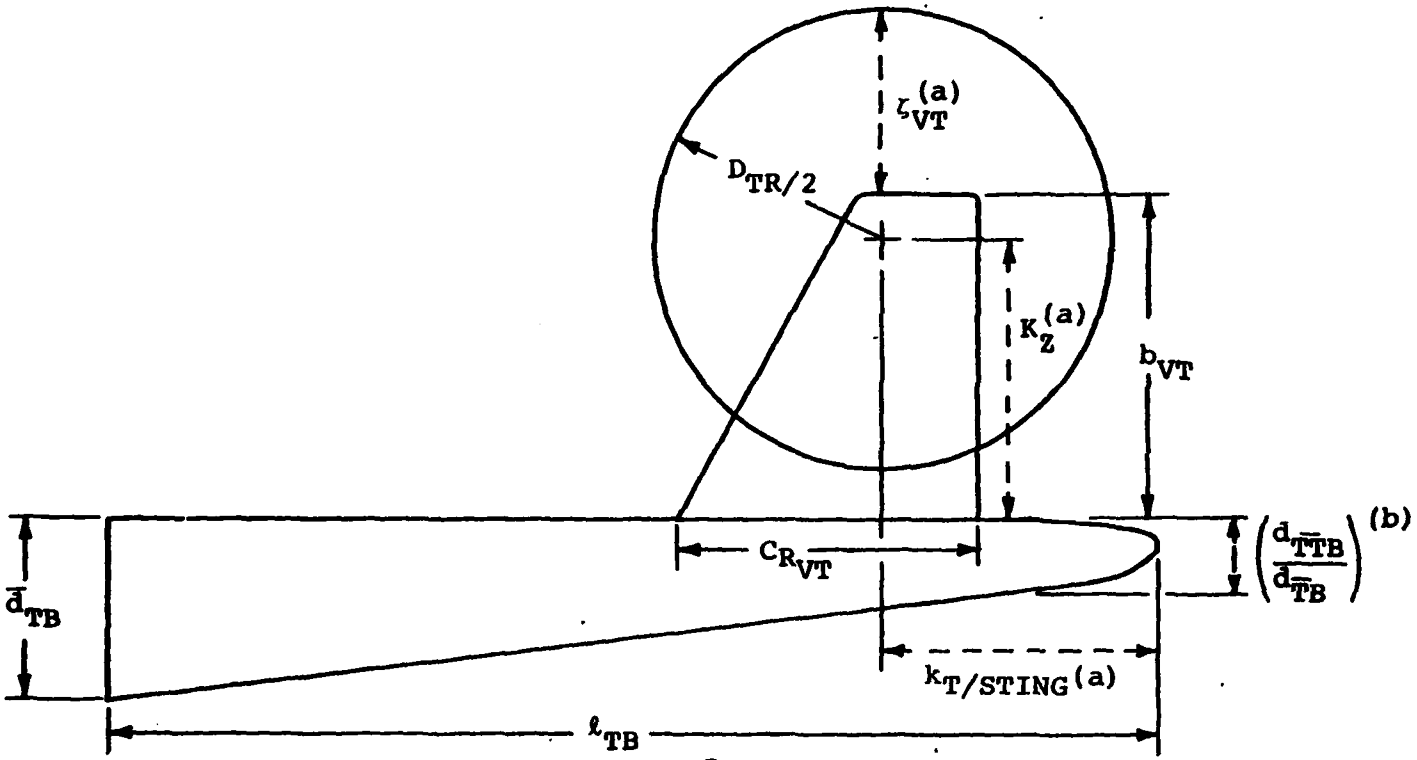
(c) $\frac{1}{2}(W_F + h_F)$

(d) $D_{MR/2}$

(e) $d_{PROP/2}$

(f) $b_{W/2}$

Figure 2-1. Typical Helicopter Geometry ∿ Single Rotor Helicopter (Part 1 of 2).



NOTES:

1. $K_Z = b_{VT} = \frac{D_{TR}}{2}\,[K_Z + (1-\zeta_{VT})]$

   WHEN CNFIND = 1.0
   VTFIND = 1.0
   TRDIND = 0.0

$$\left.\begin{aligned}\lambda_{VT} &= \frac{C_{T_{VT}}}{C_{R_{VT}}}\\ AR_{VT} &= \frac{b_{VT}^{\ 2}}{S_{VT}}\end{aligned}\right\}$$

2. BROKEN DIMENSION LINE INDICATES THAT THE SYMBOL REPRESENTS THE LENGTH AS A FRACTION OF THE DIMENSION CORRESPONDING WITH THE SUPERSCRIPT:

   (a) $\frac{D_{TR}}{2}$ (b) $d_{\overline{TB}}$

Figure 2-1. Typical Helicopter Geometry ∿ Single Rotor Helicopter (Tail Boom/Tail Fin/Tail Rotor Geometry) (Part 2 of 2).

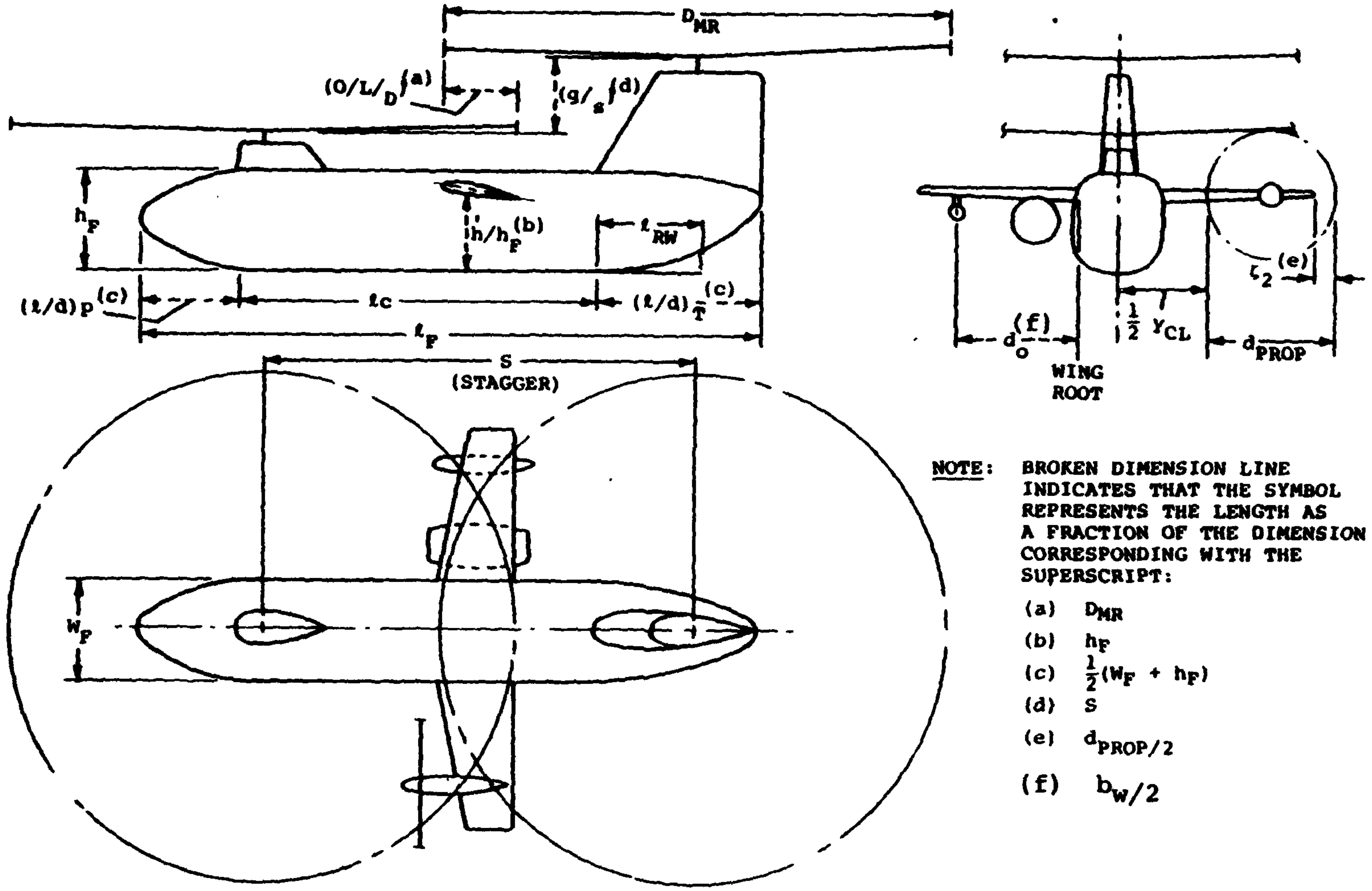
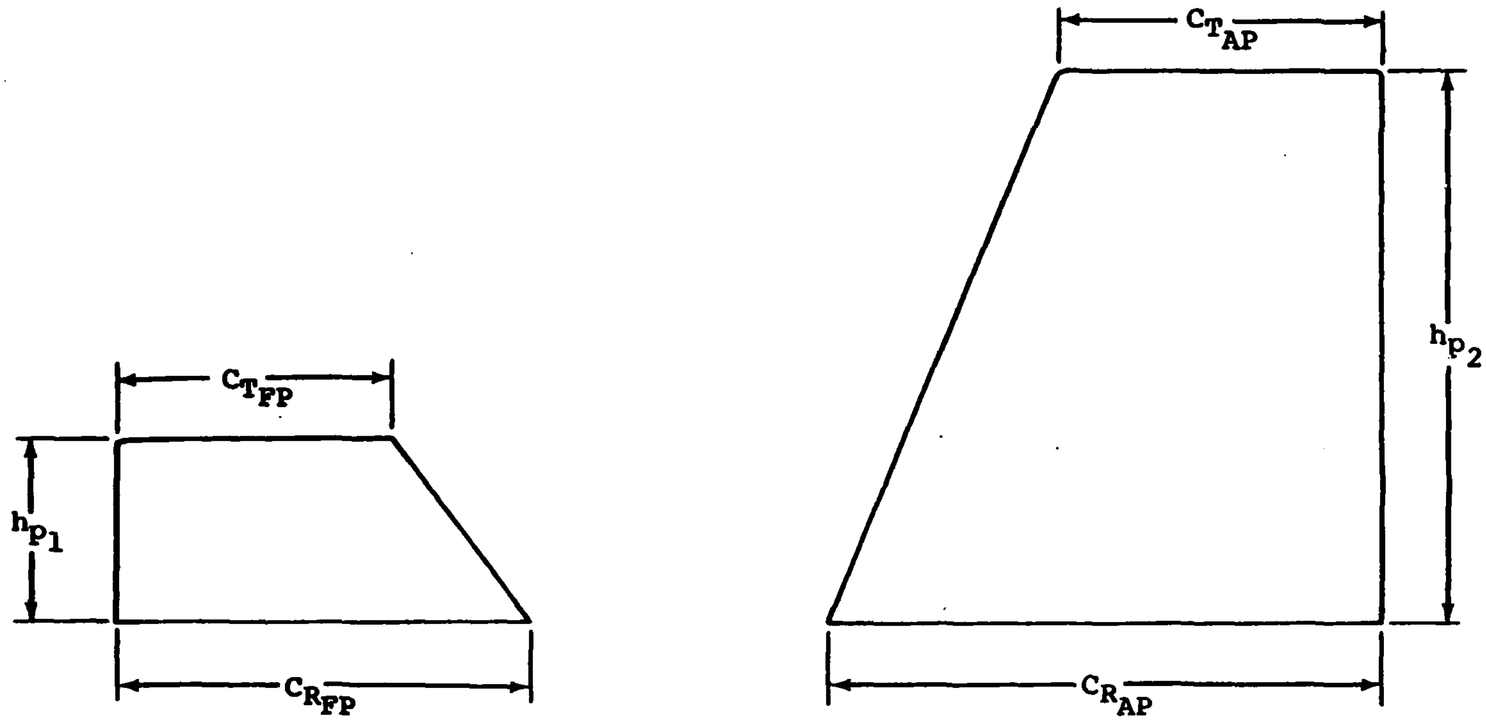


Figure 2-2. Typical Helicopter Geometry ∿ Tandem Rotor Helicopter (Part 1 of 2).



FORWARD OR MAIN ROTOR PYLON

$$\lambda_{FP} = C_{T_{FP}}/C_{R_{FP}}$$

$$AR_{FP} = \frac{2h_{p_1}}{C_{R_{FP}}(1 + \lambda_{FP})}$$

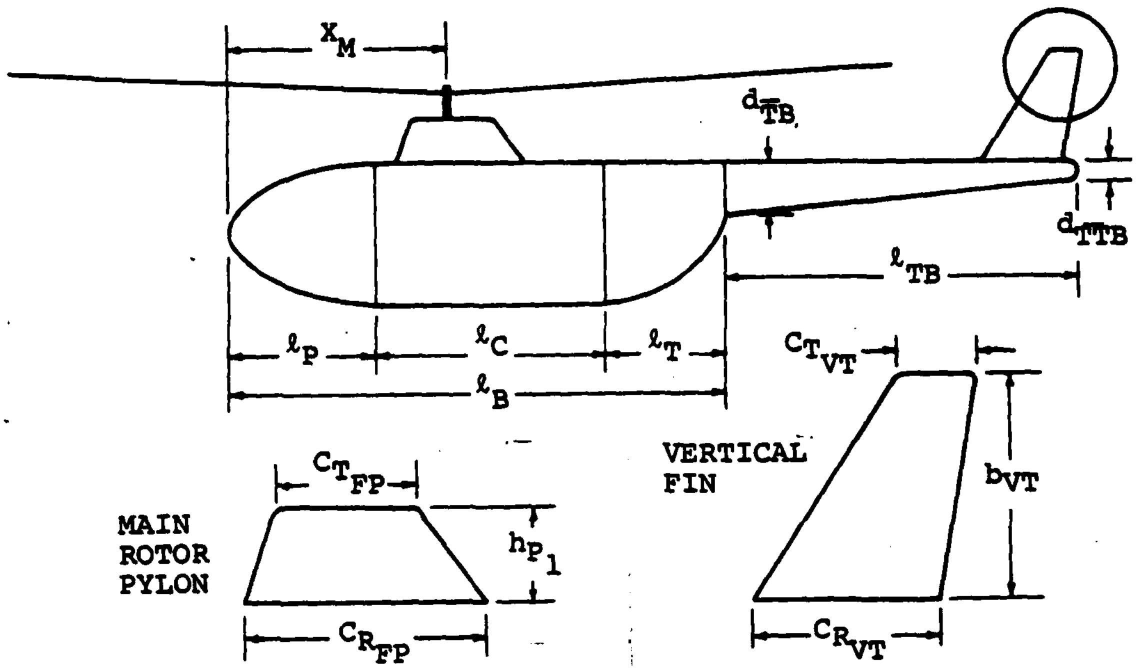
AFT ROTOR PYLON

$$\lambda_{AP} = C_{T_{AP}}/C_{R_{AP}}$$

$$AR_{AP} = \frac{2h_{p_2}}{C_{R_{AP}}(1 + \lambda_{AP})}$$

Figure 2-2. Typical Helicopter Geometry ∿ Tandem Rotor Helicopter (Rotor Pylon Geometry) (Part 2 of 2).

TABLE 2-1. TYPICAL GEOMETRIC CHARACTERISTICS - SINGLE ROTOR HELICOPTERS



$$\lambda_{FP} = \frac{C_{T_{FP}}}{C_{R_{FP}}} \qquad \lambda_{VT} = \frac{C_{T_{VT}}}{C_{R_{VT}}}$$

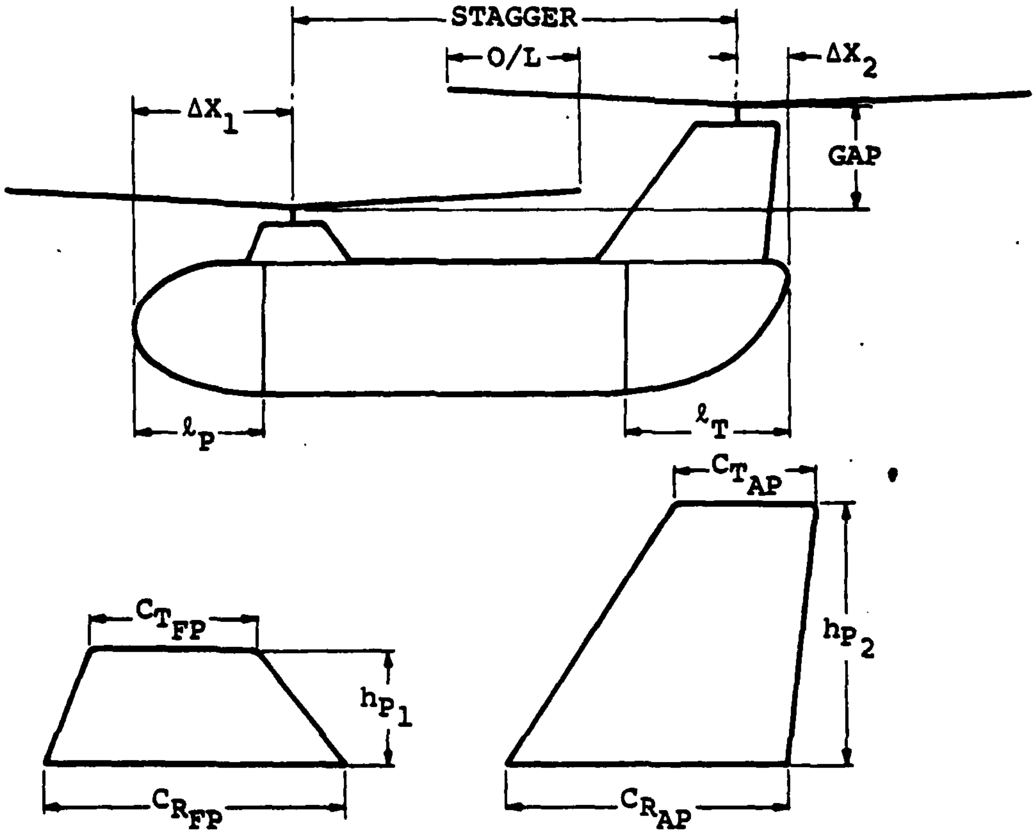
$$AR_{FP} = \frac{{h_{P_1}}^2}{S_{FP}} = \frac{2h_{P_1}}{(C_{R_{FP}} + C_{T_{FP}})} \qquad AR_{VT} = \frac{{b_{VT}}^2}{S_{VT}}$$

S_{FP} = Planform area $\qquad d_{\bar{F}} = \frac{W_F + h_F}{2} \qquad$ S_{VT} = Planform area

DATA

TYPE	AIRCRAFT	$\ell_P/\bar{d}_F$	$\ell_T/\bar{d}_F$	X_M/ℓ_B	$\ell_{TB}/d_{\overline{TB}}$	$d_{T\overline{TB}}/d_{\overline{TB}}$	λ_{FP}	AR_{FP}	λ_{VT}	AR_{VT}
"PURE LIGHT HELICOPTERS	BOE BO-105	1.02	.75	.57	7.00	.69	.41	.30	.33	1.37
	BELL OH-58A	1.12	.71	.55	8.50	.35	.53	.15	.64	4.37
"PURE" LT. TRANSPORT HEL.	BELL UH-1B	.84	.77	.71	5.55	.32	.88	.12	.23	1.98
"PURE" MEDIUM TRANSPORT HELICOPTERS	SIK H-34A	.52	.67	.44	2.42	.42	.44	.22	.64	.96
	SIK CH-3C	.78	1.13	.44	4.45	.64	.83	.25	.75	1.72
	SIK CH-53A	.76	1.47	.42	4.38	.94	.74	.21	.62	2.14
	SIK H-37A	.60	-	.56	2.30	.47	.45	.23	.63	3.36
WINGED HELICOPTERS	BELL AH-1G	2.47	.44	.65	4.91	.42	.70	.27	.48	1.53
	SIK S-67	2.22	1.98	.62	4.17	.47	.83	.27	.48	1.90
COMPOUND HELICOPTERS	LOCK XH-51A	1.29	.98	.48	5.92	.26	.89	.33	.60	.73
	LOCK AH-56A	1.40	1.36	.62	4.43	.52	.77	.12	.46	1.29

TABLE 2-2. TYPICAL GEOMETRIC CHARACTERISTICS TANDEM ROTOR HELICOPTERS



$$\lambda_{FP} = \frac{C_{T_{FP}}}{C_{R_{FP}}} \qquad \lambda_{AP} = \frac{C_{T_{AP}}}{C_{R_{AP}}}$$

$$AR_{FP} = \frac{{h_{P_1}}^2}{S_{FP}} \qquad AR_{AP} = \frac{{h_{P_2}}^2}{S_{AP}}$$

S_{FP} = planform area $\qquad$ S_{AP} = planform area

$$d_F = \frac{W_F + h_F}{2}$$

TYPE	AIRCRAFT	ℓ_P/d_F	ℓ_T/d_F	$\frac{O/L}{D}$	GAP/STAG	$\Delta X_1/\ell_P$	$\Delta X_2/\ell_T$	λ_{FP}	AR_{FP}	λ_{AP}	AR_{AP}
"PURE" LIGHT TRANSPORT HELICOPTER	B-V HUP-1	.73	1.03	.37	.08	1.00	1.00	.38	.35	.57	.78
	B-V H-21	.64	2.19	.04	.00	.89	.02	.35	.45	.23	.43
"PURE" MEDIUM - HEAVY TRANSPORT HELICOPTERS	B-V CH-46A	.71	1.53	.33	.14	1.16	.51	.63	.34	.69	.61
	B-V CH-47C	.69	1.29	.34	.12	.85	.59	1.00	1.10	.81	.53
	B-V YH-16A	.84	1.81	.37	.16	.48	.84	.34	.25	.58	.84
	B-V MOD 347	.85	1.37	.23	.15	.73	.55	.98	.43	.84	.66

TABLE 2-3. LIST OF ENGINE CYCLES

	1970	Intermediate	Advanced
<u>Primary Propulsion</u>			
Turboshaft			
Engine press. ratio	13, 16	13, 16, 19	13, 16, 19, 22
Turb. inlet temp.	2600°R	2900°R	3200°R
<u>Auxiliary Independent Propulsion</u>			
Turboshaft			
Engine press. ratio	13, 16	13, 16, 19	13, 16, 19, 22
Turb. inlet temp.	2600°R	2900°F	3200°R
Turbojet			
Engine press. ratio	13, 16	13, 16, 19	13, 16, 19, 22
Turb. inlet temp.	2600°F	2900°	3200°R
Turbofan			
Engine press. ratio	16, 20	16, 20, 24	16, 20, 24, 28
Turb. inlet temp.	2600°R	2900°R	3200°R
Fan bypass ratio	2, 4, 6	2, 4, 6	2, 4, 6

2.3 HELICOPTER WEIGHT SUMMARY

A detailed helicopter weight summary is provided by the program through use of statistical weight trend equations. A description of, and justification for, these equations is given in Section 4.11. Three major categories of weights are calculated: the propulsion group, the structures group, and the flight controls group.

2.4 AERODYNAMIC CHARACTERISTICS

The aerodynamic data which are calculated by the program are the helicopter drag and (in the case of winged or compound helicopters) the lift curve slope of the wing (used for calculations of the gust load factor). Drag data may be input to the program in a variety of forms including a single point value of flat plate area, drag trends, or by a detailed drag summary. Scaling effects on drag based upon Reynolds number corrections are included. Wing spanwise loading efficiency (Oswald's factor) may be either input to the program or may be program calculated.

2.5 ROTOR CHARACTERISTICS

Rotor performance may be calculated either by the short form aerodynamic performance method or by using input rotor maps. The short form method employs input rotor "cycles". Corrections for the specific rotor and helicopter configuration geometry,(e.g., blade twist, number, cut-out, rotor overlap, etc.) being analyzed are made by the program. Included with the program is a brief library of currently available "cycles" (Table 2-4 lists their pertinent characteristics).

Two types of rotor maps, differing in the type and format of the input data required, may be used. These are designated as Type I and Type II rotor maps and their differences are noted in Section 3.1.5. The Type I rotor map may be used in two ways. In the first case, isolated rotor data derived for a specific rotor configuration is input and, as in the short form method, blade and configuration geometry corrections are applied by the program. In the second approach, a rotor map generated from total configuration rotor power data (e.g. in the case of a single rotor helicopter, this would be the sum of main and tail rotor power) is input. No corrections are applied. Thus, the particular blade and helicopter configuration geometry inherent in the data from which the map is generated is reflected unchanged in the calculated rotor performance. The Type II rotor map may be used, however, only as outlined in the first approach noted above.

TABLE 2-4. LIST OF ROTOR CYCLES

Rotor Cycle No.	Rotor Blade Planform Char.	Rotor Blade Airfoil Section Description	Rotor Blade Spanwise Airfoil Distr. Represented in Rotor Cycle	Helicopters Employing This Rotor Blade Type
1	Constant Chord	"Conventional" symmetrical NACA airfoil section	NACA 0012 from $C.L._{ROT}$ to blade tip	CH-47A UH-1B SH-3A
2	Constant Chord	Cambered blade section developed by modification of NACA 230 (5 digit) series airfoil section	BV 23010-1.58 from $C.L._{ROT}$ to blade tip	CH-47C MOD. 347 BO-105C
3	Constant Chord	High speed (transonic) airfoil section (s) developed from NACA 6 - series airfoil sections and optimized for maximum lift and low pitching moments.	BV VR-7 from $C.L._{ROT}$ to r/R = 0.85 BV VR-8 at blade tip (r/R = 1.00)	HLH (XCH-62)

3.0 PROGRAM OPERATION

3.1 GENERAL

3.1.1 The Option Indicator

As previously described, the program [illegible] two major options, a third which is a combination of these [illegible], and a fourth option used for obtaining aircraft weight only. The specific option to be used is selected by means of an input "option indicator" abbreviated OPTIND.

OPTIND = 0

This is an iterative routine which determines only the aircraft weight, dimensions, and power.

OPTIND = 1

This is an iterative routine which determines the aircraft weight, dimensions, and required power to satisfy a prescribed mission flight profile. In addition to the flight profile, certain characteristics describing the type of aircraft are specified, such as the wing aspect ratio, thickness ratio, the wing loading or disc loading, the engine cycle, etc.

OPTIND = 2 or 3

These options are used to calculate the flight performance of an aircraft for which the size is fixed. In addition to the aircraft characteristics described above, the power available, aircraft dimensions, etc. are input to the program. A flight profile is also specified. The program then calculates the performance history of the aircraft for the specified mission.

If OPTIND = 2 is selected, the aircraft gross weight is input and the fuel required to fly the specified mission is determined. This option is useful for solving many different performance problems where it is desired to constrain gross weight, such as calculating climb performance, cruise performance, or payload-range capability.

If OPTIND = 3 is selected, the operating-weight-empty is input and takeoff gross weight and required fuel load is determined. This option is useful for calculating various overload off-design weights and for determining ferry performance.

Combined Option

This option permits the user to size an aircraft for a "design-point" mission and then to calculate the off-design-point performance of the sized aircraft for a variety of additional missions. Basically, this option causes the program to run option number one (OPTIND = 1), save the sizing data generated in that option, and then input this information into the performance option (OPTIND = 2).

3.1.2 Description of Mission Profile

The performance calculation subprogram in HESCOMP, consisting of nine individual subroutines, permits the simulation of aircraft performance for virtually any mission flight profile. A typical performance analysis is made up of a series of elements which, in building block fashion, allows the user of the program to perform a wide variety of studies. The elements of a typical performance analysis are:

1. Segment - A segment of a mission profile is a unique portion of the mission such as a cruise or a climb. A segment starts with a set of initial conditions of one or more of the variables of state (altitude, range, weight, etc.) and ends when a terminal condition (or conditions) has been satisfied.

2. Hop - A hop is defined as a set of segments ending at some logical terminal locations (such as ground level at the desired range). Thus, a hop might consist of flying from location "A" to location "B" by means of combining the following segments: taxi, takeoff, climb, cruise, descent, landing, and taxi.

3. Leg - A leg of a mission is herein defined as a set of hops ending in a re-fueling of the aircraft. Thus, a leg might consist of flying from location "A" to "B", then to "C", at which point the aircraft is refueled.

4. Mission - A mission is defined in this program as a set of legs (or hops or segments) which satisfy some specific operational requirement. In this program, the mission is the basic element for which the aircraft is sized.

5. Case - A case is a consecutive series of missions for the same aircraft. This program permits the user to analyze a case which consists of a mission for which an aircraft is sized, followed by a different mission which the now-sized aircraft performs, followed by yet additional missions.

The performance calculations subprogram consists of nine individual performance segments, specified by means of an input indicator, SGTIND. The segments are taxi (SGTIND = 1), hover (SGTIND = 2), climb (SGTIND = 3), cruise (SGTIND = 4), descent (SGTIND = 5), loiter (SGTIND = 6), an increment in weight of fuel (SGTIND = 7) or payload (SGTIND = 8), a transfer of altitude (SGTIND = 9), and general performance (SGTIND = 11). The end of the mission is specified by an input SGTIND = 0. An array of segment indicators is input to the program to specify the mission being studied. Thus, a typical array might be:

SGTIND =

1,2,3,4,5,2,1,1,2,3,4,3,4,5,2,7,2,3,4,5,4,5,6,2,1,0,

Segments　　　　　　　　　　Refueling

hop #1　　hop #2　　hop #3

leg #1　　leg #2

mission

At the end of any leg, the sum of segment fuel required to perform that leg is stored in the computer. At the end of the mission, the largest of these stored values is used to determine the aircraft sizing requirements when OPTIND = 1. An end of a case is specified by an input SGTIND = 100. Since an end-of-case is also always an end-of-mission, it is not necessary to end a case by a SGTIND = 0 followed by SGTIND = 100. SGTIND = 100 always takes precedence over SGTIND = 0. The distinction between a mission and a case is most useful when it is desired to size an aircraft for a specified mission followed by analysis of the off-design-point performance of the "sized" aircraft on other missions. As an example, with SGTIND = 1 (sizing option) the following array of SGTIND might be used:

SGTIND =

1, 2, - - - - 0, 2, - - - - 0, 1, - - - - 0, 1, - - - - 100

1st mission | 2nd mission | 3rd mission | 4th mission

Case

The program will size the aircraft for the first mission and then analyze the performance of the "sized" aircraft for the second, third and fourth missions. Up to 50 consecutive segments may be included in a single case, arranged in any arbitrary series of hops, legs, and missions. Up to 10 of any specific segments may be included in any case. Thus, a case might consist of several missions, each mission having several different cruise segments.

Each segment is a discrete element of the mission, independent of any other segment with the exception of the influence on the altitude, range, weight, and time. That is, the first

cruise of a case might be at cruise power at standard atmospheric conditions and the second cruise could be at best specific range for a nonstandard day.

At the start of a case, the user inputs values for initial conditions of altitude, range, weight, and time. The first segment of the case uses these values as initial boundary conditions and the segment ends at a specified terminal condition. The final values of altitude, range, weight, and time then become, in turn, the initial values for the following segment.

The final, or terminal, condition varies depending upon the segment. Terminal conditions for each segment, input by the user, are:

Taxi - increment in time

Takeoff, Hover, and Landing - increment in time

Climb - altitude at end of climb

Descent - altitude at bottom of descent and, for certain options, range at end of descent

Loiter - increment in time

Change of Fuel Weight - increment in weight and increment in time

Change of Payload Weight - *increment in weight and increment in time*

Transfer Altitude - final altitude

General Performance - increment in velocity

Segments 2 through 6 (takeoff, hover, and landing through loiter) and segment 11 (general performance) require, in addition to terminal conditions on one of the variables of state, an input value for the step size to be used in the calculations. The step size specifies both the increment in the primary variable which is used in the calculations and the increment between successive printouts. Printouts occur at even integral multiples of the primary variable. Thus, if an aircraft is required to climb from a starting value of altitude of 6300 feet to a final value of 29,500 feet, and the step size is specified as 1000 feet, the program will calculate and print at 6300 feet, 7000 feet, 8000 feet, etc. to 29,500 feet. As the step size is decreased, the program accuracy improves, but the computing time lengthens.

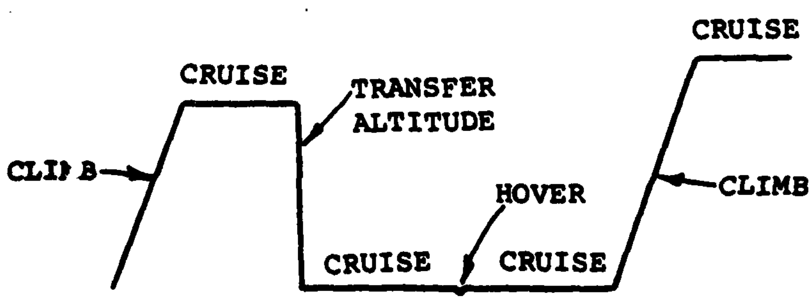
Atmospheric conditions may vary from segment to segment. For example, the first segment, a climb, may be for a standard atmosphere; the second segment, a cruise, may use a constant increment in temperature above standard; and the third segment,

another climb, may use a nonstandard temperature versus altitude table. The third atmosphere option requires a tabular input of temperature ratio versus altitude. Only one nonstandard tabular atmosphere may be used in a single case. Segments 1 through 6 (taxi through loiter) may be used to simulate an additional requirement for reserve fuel. The reserve fuel calculated in this manner is used as part of the total fuel required to size the aircraft. However, the aircraft weight is not reduced by the amount of the reserve fuel. This option is specified by inserting a value of 10 x SGTIND for the particular mission segment indicator where reserve fuel is to be calculated. For example, if it is desired to calculate reserve fuel at a specified cruise condition, *SGTIND = 40*; i.e., (SGTIND = 4) x 10 is input.

3.1.3 Special Flight Path Control Option

h_{OPT}IND - This indicator will permit the user to fly a mission at the optimum altitude for best fuel consumption. The program will automatically determine the best altitude for any cruise segment which is preceded by either a climb segment or a transfer of altitude. If the cruise is preceded by a climb, the program will determine the flight altitude which minimizes the sum of the fuel for climb and cruise. If the cruise is preceded by a transfer altitude, the program will determine the altitude for the best fuel consumption during cruise only.

In addition to specifying that optimum altitude flight is desired during the mission, the user may specify a maximum altitude permitted for each cruise segment. This is specified by means of the h_{MAX} input for the preceding climb or the h_{FINAL} input for the preceding transfer altitude. The maximum altitude specification is useful in studying missions for which some of the cruise segments are to be optimized while other cruise segments are to be flown at known altitude such as the high-low-low-high mission shown below in which the low altitude segments represent sea level dashes. For this mission, the user specified h_{FINAL} = 0 for the transfer altitude segment.



3.1.4 Propeller Efficiency

Propeller efficiency can be calculated in three different ways for compound and auxiliary propulsion helicopters. The option chosen is specified by means of a propulsive efficiency indicator, $\eta pIND$. The options range from (a) input of a set of point values of efficiency to (b) input of a prop map table to (c) automatic calculation of propeller performance. The option chosen will depend on the type of problem being studied as each of the means of calculating prop performance has features which may be desirable under certain conditions. These options are described in more detail in Section 4.7.

3.1.5 Rotor Power Required Calculation

The method most likely to be used, and certainly the most convenient, from the point of view of inputs, is the short form aerodynamic performance method. Rotor blade performance data is input in the form of "cycles", with corrections for the specific rotor and helicopter configuration under study being applied by the program.

Two types of rotor maps may be input. These differ in the type and format of the input data required. The Type I rotor map requires Cp_H/σ as a function of C_T/σ and M_{TIP} (hover performance) and C_P/σ as a function of μ, C_T'/σ, and C_X/σ (cruise performance). The Type II rotor map requires F.M. as a function of C_T/σ and M_{TIP} (hover performance) and rotor L/D_E as a function of μ, C_T'/σ, and X/L (cruise performance). The Type I rotor map data may be input in two ways. The first utilizes isolated rotor data derived for a specified rotor configuration, but corrected by the program for the specific rotor and helicopter configurations under study. The second uses total configuration rotor data (i.e., in the case of a single rotor helicopter, this would include both main and tail rotor power) and applies no corrections to the data. The Type II rotor map option <u>always</u> uses isolated rotor data derived for a specified rotor configuration, but corrected by the program for the specific rotor and helicopter configuration under study.

The short form aerodynamic performance method, and the Type I (1st version) and Type II rotor map options are suitable for use both in sizing and performance only calculations, since corrections for variations in rotor and helicopter configurations are applied. The Type I (2nd version) rotor map option, however, must be restricted to use only in non-sizing applications. Possible areas of use could be, for example, the case where (a) it is inconvenient for the magnitude of the particular application to generate the data required for creating a rotor cycle or generalized rotor map, or (b) in calculating the mission performance of existing helicopters (e.g. the HH-43B, WG-13, UH-2, etc.) utilizing rotor maps derived from Flight Handbooks, etc.

3.2 PROGRAM OPTIONS

Flexibility of operation and generality of approach have been accomplished by use of many optional computation paths. The path to be used is selected by the user through use of a series of input indicators. Besides the option indicator, previously described, the program indicators fall into seven categories: propulsion indicators, aerodynamics indicators, size trends indicators, mission performance indicators, flight path control indicators, an atmosphere indicator, and an optional print indicator. The indicators and their use are described below. A summary list of all indicators and their values is included in Section 5.3.2.

3.2.1 Propulsion Indicators

AIPIND - Indicator which differentiates between compounds with and without auxiliary independent engines. AIPIND = 1 denotes a compound helicopter having a single set of engines connected both to the main rotor and auxiliary propulsion systems. AIPIND = 2 indicates a compound helicopter with independent engines for auxiliary propulsion.

ENGIND - Two different classes of cruise engines are included in the program. They are "horsepower producing" engines and "thrust producing" engines. The horsepower producing engines which are included in the standard engine library are turbo-shaft engine cycles. The thurst producing engines in the engine library are either turbojet or turbofan engines. If ENGIND = 0, a power producing cycle is selected. If ENGIND = 1, a thrust producing cycle is selected.

ESCIND - The program permits the user to size the primary engines either for takeoff conditions only or for the more critical choice of takeoff or cruise. This is specified by means of the engine sizing indicator, ESCIND. If ESCIND = 1, the program will size the engines for takeoff conditions only. If ESCIND = 2, the program will size the engines for takeoff, then cross-cneck the engine size required for cruise conditions, and pick the more critical of the two conditions.

FIXIND - Engines selected for aircraft being studied in the program may be either "fixed" in size or "rubberized." If the engines are "rubberized," the engine sizing subroutine calculates the maximum power or thrust of the engines required to satisfy certain specified criteria. If the engines are fixed in size, the user inputs the level of maximum power or thrust for the engines and the engine sizing subroutine is bypassed. The user specifies the option of calculation by means of the input indicator, FIXIND. If FIXIND = 0, the engines are fixed in size. If FIXIND = 1, the engine sizing subroutine is used to calculate the size of the "rubberized" engines.

FIXINDI - FIXINDI serves the same function for the auxiliary independent engines that FIXIND does for the primary engines.

POWIND - This indicator specifies the limiting power setting to be used in climb, cruise, and for engine sizing at cruise conditions: maximum (POWIND = 0), military (POWIND = 1), and normal (POWIND = 2). A separate value of this indicator is input with each climb and cruise and for engine sizing.

WDTIND, QIND, N1IND, N1θIND, N2IND - These indicators specify to the program that the primary engine performance is restricted by a maximum level of fuel flow, torque, gas generator shaft rpm, gas generator referred shaft rpm, or power turbine (output) shaft rpm. An input zero value for these indicators will permit operation restricted only by power setting (turbine temperature) limits. A unity input for any of the indicators will cause the engine operation to also be restricted by a maximum level of the appropriate variable. More than one of these indicators may be set to unity at the same time, thus simulating performance of an engine operating with multiple restrictions. N2IND has a third possible value which the user may input for turboshaft engines, N2IND = 2. This input specifies that the engine is operating at a known discrete value of output shaft speed (in general, not the optimum value). If this option is used, the user inputs the level of N_{II} for each flight segment, and the program will calculate the effect on engine performance.

WDTINDI, QINDI, N1INDI, N1θINDI, N2INDI - These indicators specify to the program that the auxiliary independent engine performance is restricted by a maximum level of fuel flow, torque, gas generator shaft rpm, or power turbine (output) shaft rpm. An input zero value for these indicators will permit operation restricted only by power setting (turbine temperature) limits. A unity input for any of the indicators will cause the engine operation to also be restricted by a maximum level of the appropriate variable. More than one of these indicators may be set to unity at the same time, thus simulating performance of an engine operating with multiple restrictions. N2INDI has a third possible value which the user may input for turboshaft engines, N2INDI = 2. This input specifies that the engine is operating at a known discrete value of output shaft speed (in general, not the optimum value). If this option is used, the user inputs the level of N_{II} for each flight segment, and the program will calculate the effect on engine performance.

RNOIND - The performance of real engines is sensitive to scaling effects. That is, doubling the maximum static power of the engine at sea level for standard atmospheric conditions by increasing the physical size of the engine will not cause a corresponding doubling of the power at other operating conditions. This nonlinear behavior is due to the influence of variations in the Reynolds number at the compressor inlet. RNOIND permits these effects to be accounted for on turboshaft engines through use of an input table of a correction factor on power available. If the indicator is set to unity, the tabulated correction factor may be input and will be used by the program to account for scaling effects. A zero input for the indicator will cause the program to assume that perfect scaling occurs.

RNOINDI - This indicator serves the same purpose for the auxiliary independent engines as RNOINDI serves for the primary engines.

ROTIND - Controls the selection of the rotor performance computation method. In addition to the short form aerodynamic performance method, rotor performance may be calculated with the use of two alternate forms of rotor map. The Type I rotor map (input locations 2700→3410) requires C_{P_H}/σ as a function of C_T/σ and M_{TIP} (hover performance) and C_P/σ as a function of μ, C_T'/σ, and C_X/σ (cruise performance). The Type II rotor map (input locations 3420→4130) requires F.M. as a function of C_T/σ and M_{TIP} (hover performance) and rotor L/D_E as a function of μ, C_T'/σ, and X/L (cruise performance). If ROTIND = 1, rotor performance is calculated by the short form aerodynamic performance method (requiring the input of a rotor "cycle"). If ROTIND = 2, a Type I rotor map is input with corrections being applied by the program for the specific rotor and helicopter configuration geometry being studied. If ROTIND = 3, a Type I rotor map is input, with no corrections being applied. If ROTIND = 4, a Type II rotor map is input with corrections being applied by the program for the specific rotor and helicopter configuration geometry being studies. The program accepts the V_{TIP} schedule and the TAUX/T schedule. However, TAUX/T = 2,000 cannot be used with this option. If ROTIND = 5, a Type II rotor map is input similar to ROTIND = 4. The program accepts the V_{TIP} schedule and all modes of the TAUX/T schedule. In this option, the rotor is operated at maximum L/DE with TAUX/T as output. If ROTIND = 6, a Type II rotor map is input similar to ROTIND = 4 or 5. The program accepts the V_{TIP} schedule and all modes of the TAUX/T schedule. In this option, the rotor is operated at maximum configuration L/DE with TAUX/T as output.

η_PIND - This indicator permits the user to select one of three different methods for predicting propeller performance for compound and auxiliary propulsion helicopters. If η_PIND = 0, the user can specify a set of point value efficiencies for

each climb and descent and a table of efficiency versus Mach number for cruise and loiter. An input of η_pIND = 1 will permit the user to load in a propeller performance map to be used during climb, cruise, and loiter while an input of η_pIND = 2 will permit use of an automatic subroutine within the program for calculating prop performance. It is anticipated that this latter option will be used for the majority of sizing and performance studies. The input prop map option will typically be used in cases where detailed test data is available on prop performance and it is desired to closely represent a specific propeller. The first option, permitting input of point values, is most useful for sensitivity studies or where propeller choice has not yet been made and only representative values of efficiency are desired. A more detailed discussion of these options is contained in Section 4.7.

3.2.2 Aerodynamics Indicators

DRGIND - The method of determining the total parasite drag of the helicopter is specified to the program by means of the indicator DRGIND. If DRGIND = 1, configuration parasite drag is built up in component fashion, with Reynolds number scaling. If DRGIND = 2, the parasite drag is calculated from a parasite drag trend derived from the inputs (GW/Fe) and K_{FED}.

OSWIND - The span loading efficiency factor (Oswald's efficiency factor) may be calculated by the program from an approximate relationship as a function of wing aspect ratio. If the user prefers, he may input a fixed value of the efficiency factor to the program. An input of OSWIND = 0 permits the user to input a fixed value for efficiency. An input of OSWIND = 1 will cause the program to use the approximate equation to calculate the value for efficiency.

3.2.3 Size Trends Indicators

APHIND - The aft rotor pylon height of a tandem rotor helicopter is specified by use of this indicator. If APHIND = 1, aft pylon height is input directly in feet. If APHIND = 2, the tandem rotor gap/stagger (g/s) ratio is input and aft pylon height is sized accordingly.

AUXIND - Four versions of both the single and tandem rotor helicopter may be specified through this indicator. They are: a pure helicopter (AUXIND = 1), a winged helicopter only (AUXIND = 2), an auxiliary propulsion helicopter, only (AUXIND = 3), and a compound (wings and auxiliary propulsion) helicopter (AUXIND = 4).

b_wIND - For a configuration having wings, this option determines the manner in which wing span is calculated during the sizing process. If b_wIND = 1, wing span/rotor diameter ratio (b_w/D) is input. If b_wIND = 2, wing aspect ratio (AR) is input. If b_wIND = 3 (used when dealing with wing-mounted

propellers) wing span is determined from propeller tip/ fuselage clearance considerations.

CNFIND - This indicator specifies the helicopter configuration to be analyzed. These are: the single rotor helicopter (CNFIND = 1) and the tandem rotor helicopter (CNFIND = 2).

FDMIND - Determines the manner is which a tandem rotor helicopter fuselage is sized. If FDMIND = 1, tandem rotor overlap ((O/L)/D) and forward and aft rotor positions ($\Delta X_1/l_P$, $\Delta X_2/l_T$) are specified. If FDMIND = 2, overlap and cabin length (l_C) are input. If FDMIND = 3, cabin length and forward and aft rotor positions are input.

HTIND - Permits the user to input fixed-size horizontal tail surfaces to the program or, optionally, to have the program calculate the tail surface size based upon an input tail "volume" coefficient. If HTIND = 0, the program will assume no horizontal tail exists. If HTIND = 1, the tail area may be input directly. If HTIND = 2, the program will calculate the size based upon a tail "volume" coefficient.

MRPIND - Specifies the placement of the main rotor of a single rotor helicopter on its fuselage. If MRPIND = 0, the user inputs directly the main rotor position (aft of the nose) as a fraction of body length (X_M/l_B). If MRPIND = 1, the program does a simple mass balance calculation and determines the rotor position relative to the aircraft cg. If MRPIND = 2, the same procedure is carried out as with MRPIND = 1 with the exception that the program assumes the auxiliary drive system, propeller, and auxiliary independent engines (if any) to be located on the wing.

RDMIND - Specifies manner in which main rotor is sized. If RDMIND = 1, main rotor diameter and solidity are input directly. If RDMIND = 2, disc loading and solidity are input, diameter is calculated. If RDMIND = 3, diameter and C_T/σ are input, solidity is calculated. If RDMIND = 4, disc loading and C_T/σ are input and both diameter and solidity are calculated.

S_WIND - Specifies options available for wing sizing. These are: wing area input directly (SWIND = 1), wing area sized based on an input wing loading (SWIND = 2), and wing area sized by rotor/wing maneuver requirements (SWIND = 3).

TRDIND - Determines manner in which tail rotor diameter is sized. If TRDIND = 0, the helicopter is sized without a tail rotor (Note: this indicator is only used in conjunction with CNFIND = 1.0). If TRDIND = 1, tail rotor diameter is calculated from a trend of D_{MR}/D_{TR} contained in the program. If

TRDIND = 2, tail rotor diameter is input directly. If TRDIND = 3, a value of net tail rotor disc loading, $(T/A)_{NET}$, is input and tail rotor diameter is determined through an iterative procedure.

TRSIND - Tail rotor solidity sizing indicator. If TRSIND = 1, tail rotor solidity is input directly. If TRSIND = 2, C_T/σ is input and tail rotor solidity is sized based on either hover-antitorque or hovering turn requirements.

VTFIND - Vertical tail area sizing indicator. If VTFIND = 1, vertical tail size is based on input values of aspect ratio (AR_{VT}) and tail fin/tail rotor overlap (h_{VT}). If VTFIND = 2, tail fin/tail rotor overlap and directional stability requirements, (sufficient tail area to counteract main rotor torque in cruise flight, if tail rotor is lost), dictate vertical tail area. If VTFIND = 3, the same requirements must be met as with VTFIND = 2, with the exceptions that AR_{VT} is specified and tail fin overlap is calculated along with vertical tail area.

XMSNIND - Indicator that controls drive system transmission sizing. When XMSNIND = 0.0 or 1.0 and ESCIND (LOC 0022) = 2.0, the transmission can be rated at cruise RPM input LOC (0238). If XMSNIND = 0, main, tail and auxiliary drive system ratings are specified as a fraction of primary engine installed power (in the case of a compound helicopter with auxiliary independent drive system rating is specified as a fraction of the auxiliary independent engine installed power).

XMSNIND - Indicator that controls drive system transmission sizing. If XMSNIND = 0, main, tail and auxiliary drive system ratings are specified as a fraction of primary engine installed power (in the case of a compound helicopter with auxiliary independent propulsion, the auxiliary independent drive system rating is specified as a fraction of the auxiliary independent engine installed power).

If XMSNIND = 1, the drive system ratings calculated are equal to the product of the applicable multiplicative factors (SHP_{MRX}/SHP^*_{MR}, SHP_{TRX}/SHP_{TRP*}, SHP_{AUX}/SHP^*_{AUX}) and the component (main, tail, and auxiliary) power obtained from the proportional split (based on power required) of the total sea level standard maximum (installed) engine power.

If XMSNIND = 2, main, tail, and auxiliary drive system ratings are specified at a fraction of the power required to hover or cruise at design conditions (more critical of the two conditions is selected).

If XMSNIND = 3, the same applies as in the case where XMSNIND = 2, except the most critical of the two design conditions is

compared to the drive system rating required at an alternate payload/gross weight hover at the design point conditions. The most critical of these three conditions is selected.

If XMSNIND = 4, the same applies as in the case where XMSNIND = 2, except that the tail rotor drive system rating is selected independently of the main rotor drive system to match a specified fraction of power required to hover or cruise at design conditions (more critical of the two conditions is selected).

If XMSNIND = 5, the same applies as in the case where XMSNIND = 3, except that the tail rotor drive system rating is selected independently of the main rotor drive system (as when XMSNIND = 4), and the most critical of the two design conditions is compared to the tail rotor drive system rating required at an alternate payload/gross weight hover at the design point conditions, the most critical of these three conditions being selected.

3.2.4 Mission Performance Indicators

CLMIND - Four types of climb calculations are permitted: maximum rate of climb (CLMIND = 1), constant equivalent airspeed (CLMIND = 2), constant Mach number (CLMIND = 3), and constant true airspeed (CLMIND = 4).

CRSIND - Six types of cruise missions are included in the program: cruise at fixed cruise power (CRSIND = 1), cruise at constant true airspeed (CRSIND = 2), cruise at airspeed for best specific range, (CRSIND = 3), cruise at the speed for 99% of best specific range (CRSIND = 4), cruise-climb (constant W/δ) at the speed for best specific range (CRSIND = 5), or cruise-climb at the speed for 99% of best specific range (CRSIND = 6).

DESIND - Twelve different descent paths may be calculated by the program. They are of three major types: descent at constant true airspeed (TAS)(DESIND = 1), descent at constant Mach number (DESCIND = 3). Four variations of each of these major types of descent are specified by RMAXND. It should be noted that there are no idle power or autorotative descent options available. However, depending on the descent flight conditions specified, it is possible to operate on an autorotative descent boundary (see Section 4.12.5) during a descent.

RMAXND - Used in conjunction with DESIND to specify types of descent. If RMAXND = 0, the descent flight path ends at a specified terminal range (cruise segment must be input previous to descent). If RMAXND = 1, the program checks the specified terminal range, and, if the predicted flight path will end beyond the specified terminal range value, a spiral descent path is assumed at that point; if the predicted flight path ends

before reaching the specified terminal range point, the program prints "SHALLOWER DESCENT REQUIRED". If RMAXND = 2, the descent ends at a specified minimum altitude, terminal range requirement not considered. If RMAXND = 3, the fuel used and time required for descent are calculated but no range credit given (i.e., spiral descent path).

SGTIND - The mission profile flown by the aircraft may be made up of an arbitrary sequencing of nine discrete profile segments. The segment selected is specified by means of the segment indicator, SGTIND. The segments are: taxi (SGTIND = 1), takeoff, hover and landing (SGTIND = 2), climb (SGTIND = 3), cruise (SGTIND = 4), descent (SGTIND = 5) loiter (SGTIND = 6), a change of fuel weight (SGTIND = 7), a change of payload weight (SGTIND = 8), a transfer of altitude (SGTIND = 9) and a general performance (SGTIND = 11.) By appropriate sequencing of the input values for the segment indicator, the mission profile may be made up of any arbitrary combination of these nine discrete elements. The mission is terminated by an input value for segment indicator = 0. NOTE: Segments 1 through 6 can be used for reserve fuel calculations (gross weight reset following segment) by inputing 10 times SGTIND, i.e., SGTIND = 10, 20, 30, 40, 50, or 60.

TOLIND - The indicator TOLIND is input with each takeoff, hover, and landing segment and dictates the manner in which power is calculated. If TOLIND = 1, the user inputs required thrust-to-weight ratio and vertical rate of climb ($V_{R/C}$). If TOLIND = 2, the user inputs required fractions of maximum power and vertical rate of climb (T/W ratio is computed). Both TOLIND = 1 and 2 options are calculated, based on the assumptions of hover-out-of-ground effect. If TOLIND = 3, the option is the same as 1, but the analysis includes hover-in-ground effect factors. If TOLIND = 4, the option is the same as 2, but the analysis includes hover-in-ground effect factors.

WGTIND - The change fuel and change payload segments may be used to simulate refueling, unloading or loading of passengers, or a fuel drop. There is no restriction on the amount of fuel or payload which may be removed at any point in the mission. However, during a sizing run, it would be undesirable to increase the aircraft weight (by adding fuel or payload) to a value which exceeds the initial gross weight of the aircraft. This is because the design gross weight, upon which the subsystem weights depend, is assumed to be the same as the initial gross weight at the start of the mission. During a performance run (OPTIND = 2), this restriction does not apply and the user is given the option of overloading the aircraft at any point of the mission. If WGTIND = 0, the program will not permit the maximum weight to exceed the design gross weight. This is useful if it is desired to refuel to capacity at some point in the mission. If WGTIND = 1 (and if the performance option is being

run), the program will permit the aircraft weight to exceed the design gross weight. This is useful for parametric performance studies. For example, the user can specify an array of SGTIND = 7, 4, 0, 7, 4, 0, 7, 4, 0, up to 7, 4, 100. When this is done, the program will calculate the performance in cruise at a series of different aircraft weights. The "7" segment is used to increment the design gross weight to any value of weight desired for the following cruise.

3.2.5 Flight Path Control Indicators

$h_{OPT}IND$ - By inputting $h_{OPT}IND = 1.0$, the program will automatically determine the cruise altitude for minimum fuel consumption for any cruise which is preceded by a climb or a transfer altitude. For cruise segments which are preceded by a climb, the program will find the cruise altitude for which the sum of climb fuel and cruise fuel is minimized. The user can also specify a maximum permissible altitude for each cruise segment. If $h_{OPT}IND = 0$ is input, the program will not do an optimum altitude search for the cruise segments.

3.2.6 Atmosphere Indicator

ATMIND - The atmosphere for each individual mission profile segment and for the engine sizing calculations may be either a standard or nonstandard atmosphere. Thus, the climb may be run on a nonstandard atmosphere followed by a cruise for standard day conditions. Three options, one for standard atmosphere, the other two for a nonstandard atmosphere are available. For the performance calculations, the type of atmosphere to be used is specified to the program by means of the atmosphere indicator, ATMIND. If ATMIND = 0, the program will use a standard atmosphere. ATMIND = 1 specifies a nonstandard, constant increment in temperature above standard while ATMIND = 2 specifies a nonstandard atmosphere requiring a tabular input of temperature ratio versus altitude.

3.2.7 Optional Print Indicator

Two different forms of printout are available for the mission performance data. By setting OPTIONAL PRINT INDICATOR = 0, a standard printout will occur. This consists of time, range, fuel used, aircraft weight, pressure altitude, true airspeed, primary engine turbine temperature, an engine code which specifies the condition which is dictating the primary engine operating point, and a power fraction which is the instantaneous fraction of maximum power which is being used. These data are printed for all performance segments. In addition, depending upon which segment is being used, the standard printout will include such parameters as rate of climb, equivalent airspeed, specific range, flight path angle, etc. More detailed data may be obtained by setting the OPTIONAL PRINT INDICATOR = 1.0. The data printed will then include

main rotor power and tip speed, tail rotor power and tip speed, auxiliary propulsion power and propeller tip speed, primary and auxiliary engine fuel flows, etc. The printout available from the program is described in more detail in Section 6.1.4.

3.3 PROGRAM FLOW

Figure 3-1 indicates, conceptually, the operation of the program. Program flow is monitored by a general control loop which controls the operation of a series of peripheral programs. These include eighteen minor subroutines, four major subroutines, a major subprogram, and a library of engine cycle data, and rotor "cycle" data. The characteristics of these routines are summarized in Table 3-1.

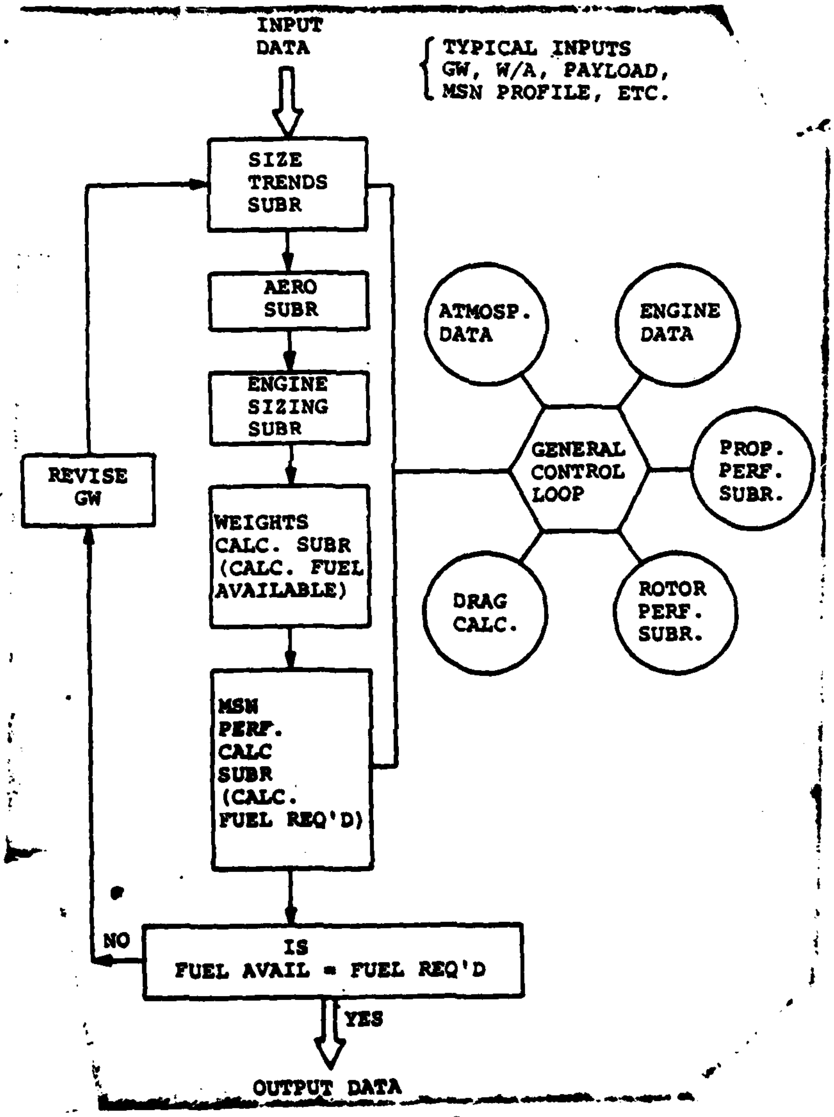


Figure 3-1. Sketch of Program Geometry.

TABLE 3-1. SUMMARY OF SUBROUTINES

ROUTINE	CALLED BY	PURPOSE
Main Control Loop (MAIN)	---	Monitors program operations, checks convergency and calculates gross weight during iterative sizing option (OPTIND = 1)
Minor Subroutines:		
Atmosphere (ATMOS)	Performance subroutines with SGTIND = 1-6, engine sizing and size trends	Calculates atmospheric density, pressure, temperature and speed of sound
DESPOW	Descent subroutine	Calculates power required for descent
Drag Calculations (DRAG)	Performance subroutines with SGTIND = 1-6, and engine sizing	Calculates aircraft propulsive force coefficient (C_x)
POWAVL	Performance subroutines with SGTIND = 1-6, engine sizing and size trends	Calculates power and fuel flow available for primary turboshaft engines by determining the most critical operating restrictions
POWAVI	Same as POWAVL	Calculates power and fuel flow available for auxiliary independent turboshaft engines by determining the most critical operation restrictions
POWREQ	Same as POWAVL	Calculates fuel flow for primary turboshaft engines when power required is less than power available.

TABLE 3-1. CONTINUED

ROUTINE	CALLED BY	PURPOSE
POWRQI	Same as POWAVI	Calculates fuel flow for auxiliary independent turboshaft when power required is less than power available
ENG1	POWREQ, POWAVL	Calculates power available for primary turboshaft engines at any specified turbine temperature, including effects of Reynold's number and operation at nonoptimum N_{II}
ENG1I	POWRQI, POWAVI	Calculates power available for auxiliary independent turboshaft engines at any specified turbine temperature, including effects of Reynold's number and operation at nonoptimum N_{II}
THRAVL	Same as POWAVL	Calculates thrust and fuel flow available for turbofan and turbojet engines by determining most critical operating restriction
THRREQ	Same as POWAVL	Calculates fuel flow for turbofan and turbojet engines when thrust required is less than thrust available
POWER	Performance Subroutines with SGTIND = 3,4,5,6 & engine sizing and size trends	Calculates propeller power required when thrust and advance ratio are known
POWERI	Same as Power	Calculates propeller power (for auxiliary independent propulsion system) required when thrust and advance ratio are known
PRINT 1 and PRINT 2	Main subroutine	Controls printout of data generated in sizing when OPTIND = 1.0

TABLE 3-1. CONTINUED

ROUTINE	CALLED BY	PURPOSE
..TLIM	Performance subroutines with SGTIND = 2,3,4,5&6	Checks main rotor operating conditions (C_t/σ and C_x/σ) to see if rotor limit has been exceeded.
ROTPOW	Performance subroutines with SGTIND = 2,3,4,5,6 and engine sizing and size trends	Calculates rotor power required (both main and tail rotors)
SCRIBE	Performance subroutines with SGTIND = 4 & 6	Controls printout when detailed print option is desired (OPTIONAL PRINT INDICATOR = 1.0)
THRUST	Same as POWER	Calculates propeller thrust available when power and advance ratio are known
Major Subroutines:		
Aerodynamics (AERO)	Main	Calculates wing spanwise loading efficiency and a series of coefficients which are used by the drag subroutine to calculate aircraft drag
Engine Sizing (ENGSZ)	Main	Calculates engine size (power or thrust) required to meet mission requirement
Size Trends (SIZTR)	Main	Calculates aircraft dimensions which are required for weight estimate and drag calculation
Weight Trends (WGHTR)	Main	Calculates aircraft weight summary including propulsion, structures, flight controls and fuel available

TABLE 3-1. CONTINUED

ROUTINE	CALLED BY	PURPOSE
Major Subprogram:		
Performance Calculations (PRFRM)	Main	Monitors program flow during calculation of mission performance and calculates total fuel required at end of mission
General Performance Calculation (PRFRP)	Performance subroutine with SGTIND=11. PRFRM	Program calculates general performance of aircraft for given altitude, temperature, and flight velocity.
Performance Subroutines		
Taxi (TAXI)	Performance subprogram	Calculates taxi performance
Takeoff, Hover & Landing (TOHL)	Performance subprogram	Calculates takeoff, hover or landing performance
Climb (CLIMB)	Performance subprogram	Calculates climb performance
Cruise (CRUS1, 2, 3)	Performance subprogram	Calculates cruise performance
Descent (DSCNT)	Performance subprogram	Calculates descent performance
Loiter (LOITR)	Performance subprogram	Calculates loiter performance
Change Fuel Weight (CHGFW)	Performance subprogram	Adds or subtracts fuel to aircraft
Change Payload (CHGPL)	Performance subprogram	Adds or subtracts payload to aircraft
Transfer Altitude (TRALT)	Performance subprogram	Changes altitude

3.4 SUBROUTINE CROSS REFERENCE

The following is a list of called subroutines by a specific subroutine.

MAIN: calls:

SIZTR	ATMOS	PRFRM
AERO	ROTPOW	
ENGSZ	WGHTR	

AERO

does not call any other subroutine

ATMOS

does not call any other subroutine

CHGRW

does not call any other subroutine

CHGPL

does not call any other subroutine

CLIMB

calls:

ATMOS	ROTPOW	THRUST	THRAVL
DRAG	POWER	POWAVI	CRUS 1, 2, 3

CRUS 1

calls:

ATMOS	ROTLIM	POWER	THRREQ
DRAG	ROTPOW	POWAVL	POWERI
POWAVL	POWREQ	THRAVL	POWAVI
			SCRIBE

CRUS 2

calls:

ATMOS	ROTPOW	POWERI	THRUST	POWREQ
DRAG	POWER	POWAVI	THRAVL	SCRIBE
ROTLIM	POWAVL	POWRQI	THRREQ	CRUS 1

CRUS 3

calls:

ATMOS	ROTPOW	POWREQ	POWRQI
DRAG	POWER	POWERI	THRREQ
ROTLIM	POWAVL	POWAVI	SCRIBE

DESPOW

does not call any other subroutine

DRAG

does not call any other subroutine

DSCNT

calls:	ATMOS	POWRQI	POWAVL
	DESPOW	THRAVL	POWREQ
	POWAVI	THRREQ	

ENGSZ

calls:	ROTPOW	ATMOS	THRUST
	POWAVL	DRAG	THRAVL
	POWAVI		

ENG 1

does not call any other subroutine

ENG 1 I

does not call any other subroutine

FORMS

does not call any other subroutine

LOADER

does not call any other subroutine

LOITR

calls:	ATMOS	POWAVL	POWREQ
	ROTLIM	POWAVI	THRREQ
	ROTPOW	THRQVL	POWRQI

POWAVL

calls: Eng 1

POWAVI

calls: Eng 1 I

POWREQ

calls: Eng 1
POWRQI
ENG 1 I

POWER

calls:	POWAVL	POWAVI
	POWREQ	POWRQI
	THRUST	

POWERI

calls:	POWAVI	
	POWRQI	
	THRUST	

PRFRM

calls:	LOADER	CLIMB	LOITR	TRALT
	TAXI	CRUS 1,2,3	CHGFW	PRFRP
	TOHL	DSCNT	CHGPL	

PRFRP

calls:	ATMOS	POWER	POWRQI	LOITR	POWAVI
	DRAG	ROTPOW	POWREQ	ROTLIM	THRAVL
	ROTPOW	POWERI	POWAVL		CRUS 1, 3

PRINT 1

calls:	LOADER
	ATMOS
	PRINT 2

PRINT 2

calls:	LOADER
	ATMOS

ROTLIM

calls:	DRAG
	ROTPOW

ROTPOW

does not call any other subroutine

SCRIBE

does not call any other subroutine

SIZTR

calls:	ATMOS	AERO
	ROTPOW	DRAG
	POWAVL	POWAVI
		THRAVL

TAXI

calls:	ATMOS	POWAVL
	THRAVL	
	POWAVI	

THRAVL

does not call any other subroutine

THREEQ

does not call any other subroutine

THRUST

does not call any other subroutine

TOHL

calls:	ATMOS	ROTPOW	THRAVL
	POWAVL	POWREQ	
	ROTLIM	POWAVI	

TRACT

calls:	CRUS 1
	CRUS 2
	CRUS 3

WGHTR

does not call any other subroutine

FUNCTIONS:

All functions do not call any other subroutine. For a complete list the functions are:

BIV	TRIV
PARA	XLINT
TABLE	XLKUP
	XIBIV

4.0 DETAILED PROGRAM DESCRIPTION

4.1 MAIN CONTROL LOOP

Figure 4-1 is a flow chart of the main control loop for the computer program. In the sizing option (OPTIND = 1), the program iterates on the aircraft gross weight until the fuel available and the fuel required are equivalent within a specified tolerance. If OPTIND = 2 or 3, the program bypasses the size trends, engine sizing, and weight trends subroutines. If OPTIND = 3, the program iterates to determine the takeoff weight and fuel required to fly a specified mission.

4.1.1 Input Card Setup

The first five columns of an input card contains information used by the input routine LOADER. A card with 77777 punched in the first five columns indicates a title card follows. The following card is an alpha-numeric title card with information in columns seven through seventy-eight as shown on the input sheets in the User's Manual. All input data are assigned a unique location in the input data file. This is indicated by the location number of each variable on the input sheets in the User's Manual. Up to five variables may be input on a card. Columns 1 through 4 contain the location number of the first variable on the card and column five the number of variables on the card. A card with 88888 punched in the first five columns indicates the end of data for that case and starts program execution. A card with 99999 in the first five columns indicates the end of the run and causes program termination. Cases can be stacked in the following manner.

77777	Card
	Title Card
	Data Cards
88888	Card
77777	Card
	Title Card
	New Data Cards
88888	Card
99999	Card

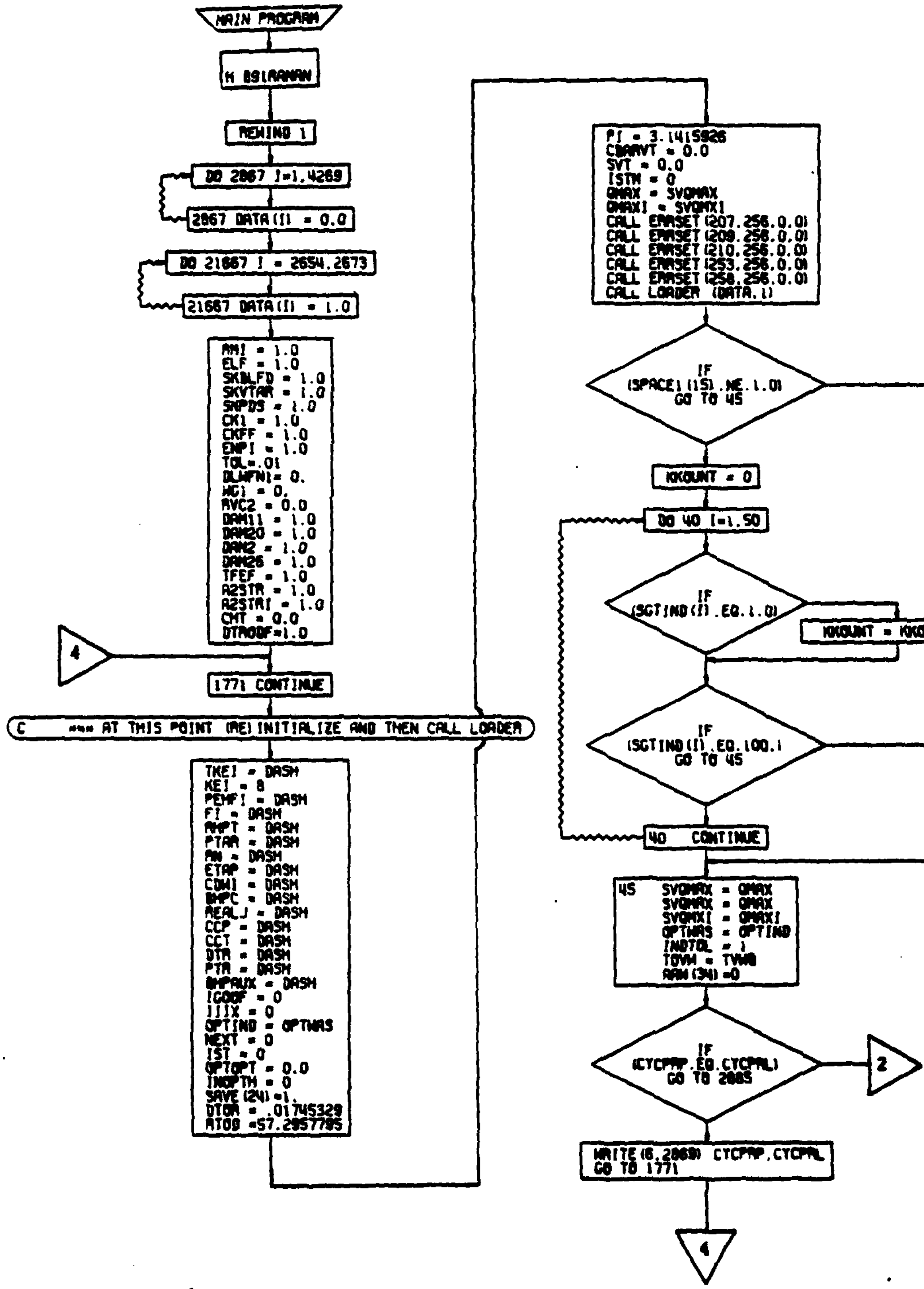


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 1 of 13)

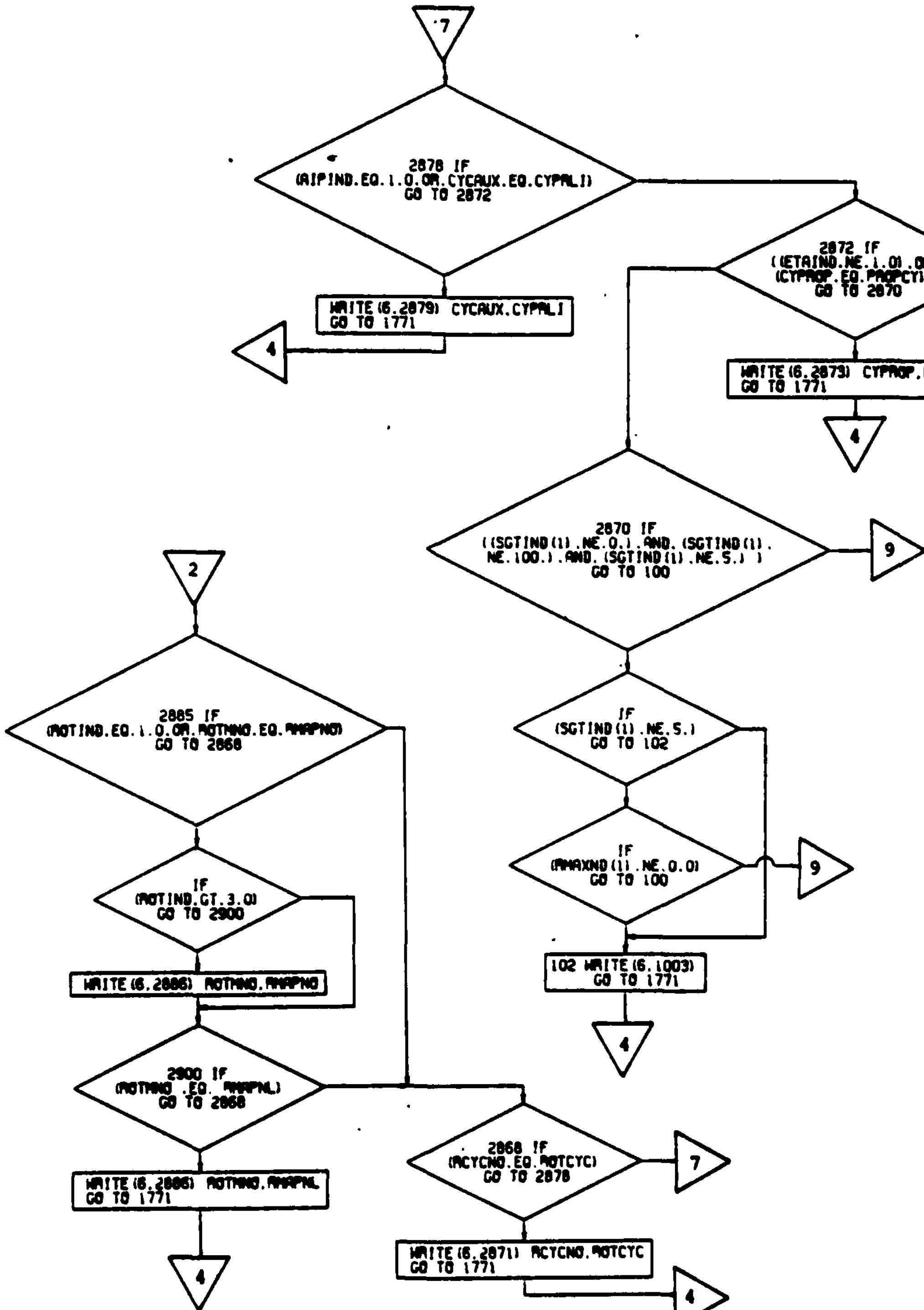


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 2 of 13)

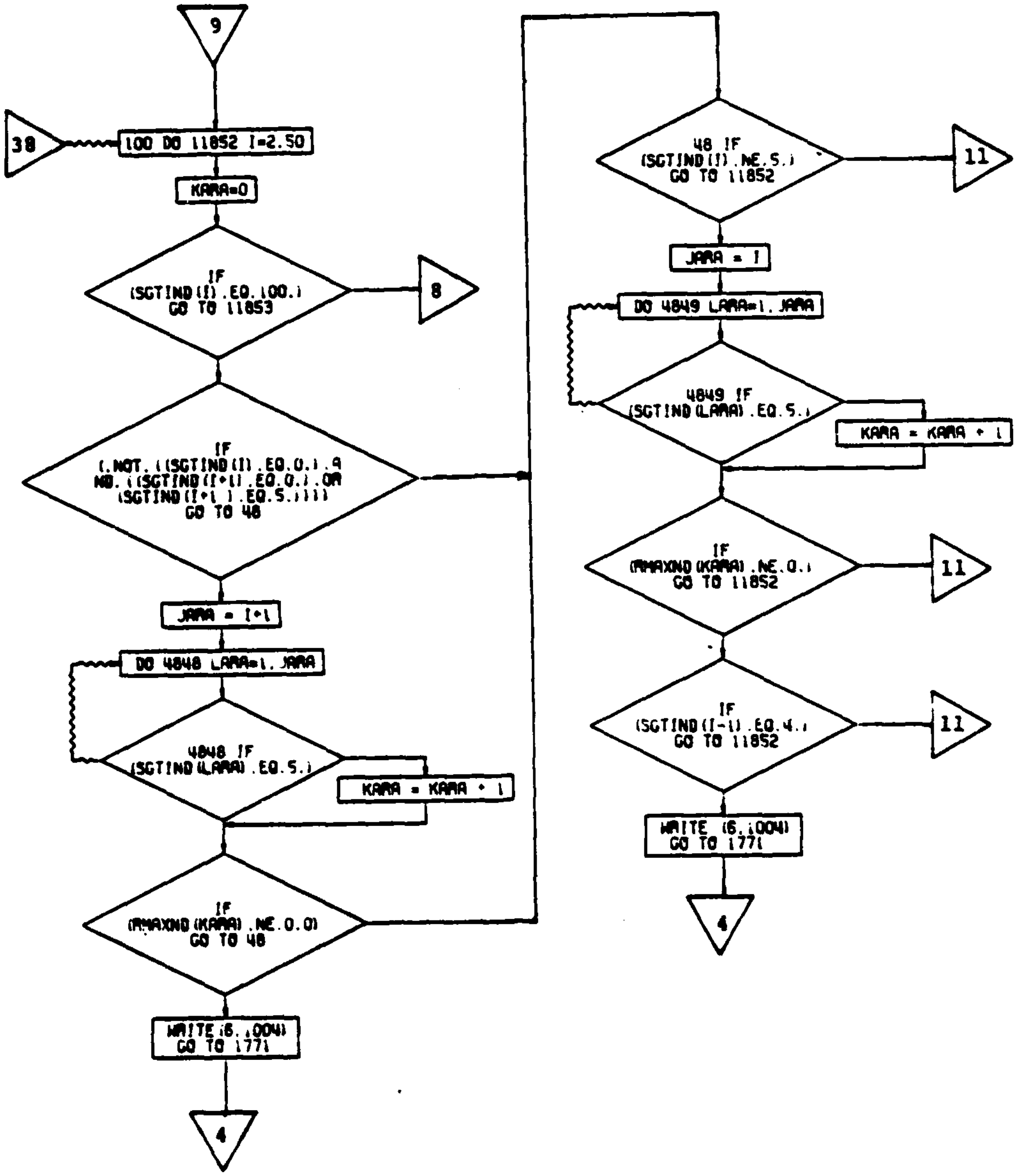


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 3 of 13)

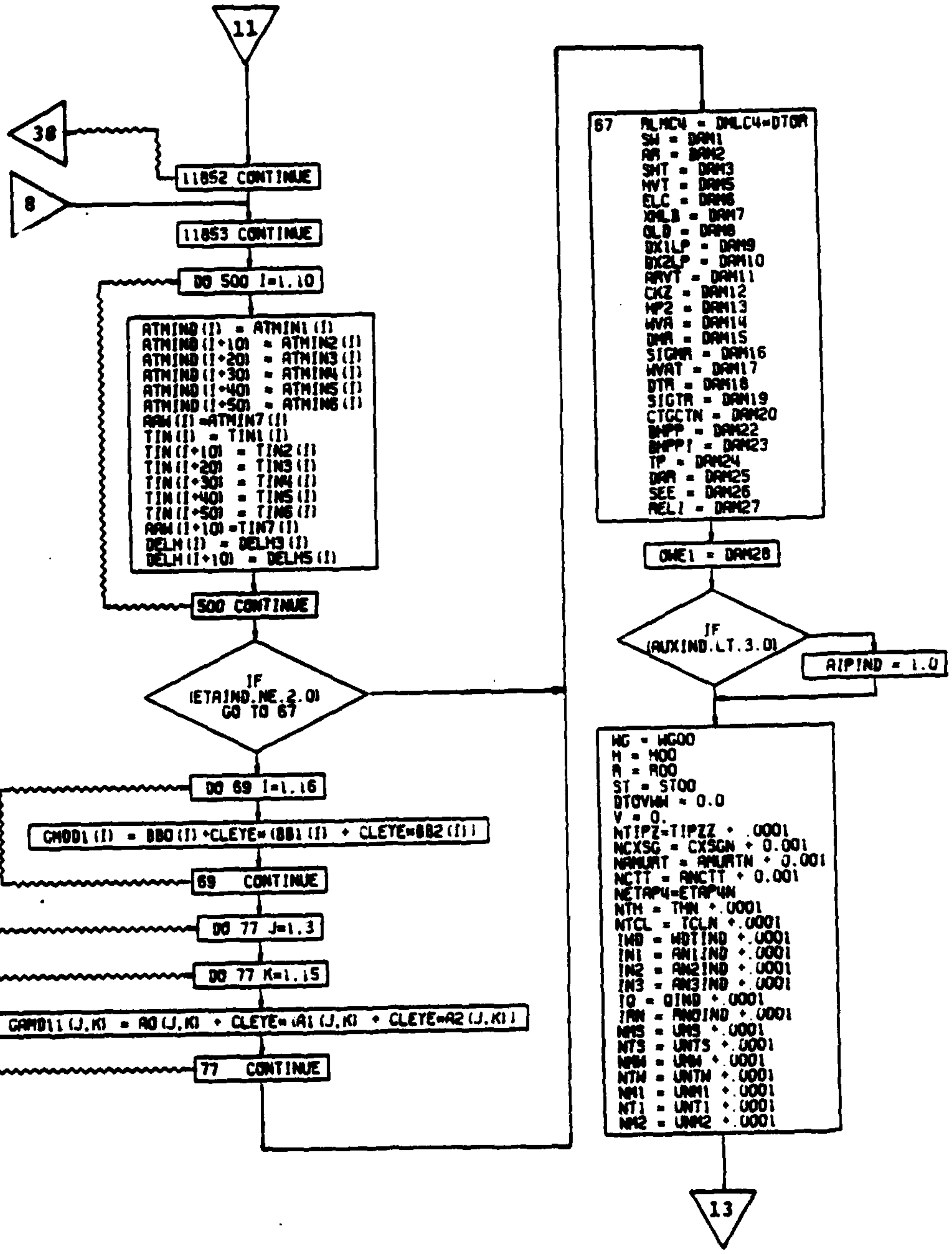


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 4 of 13)

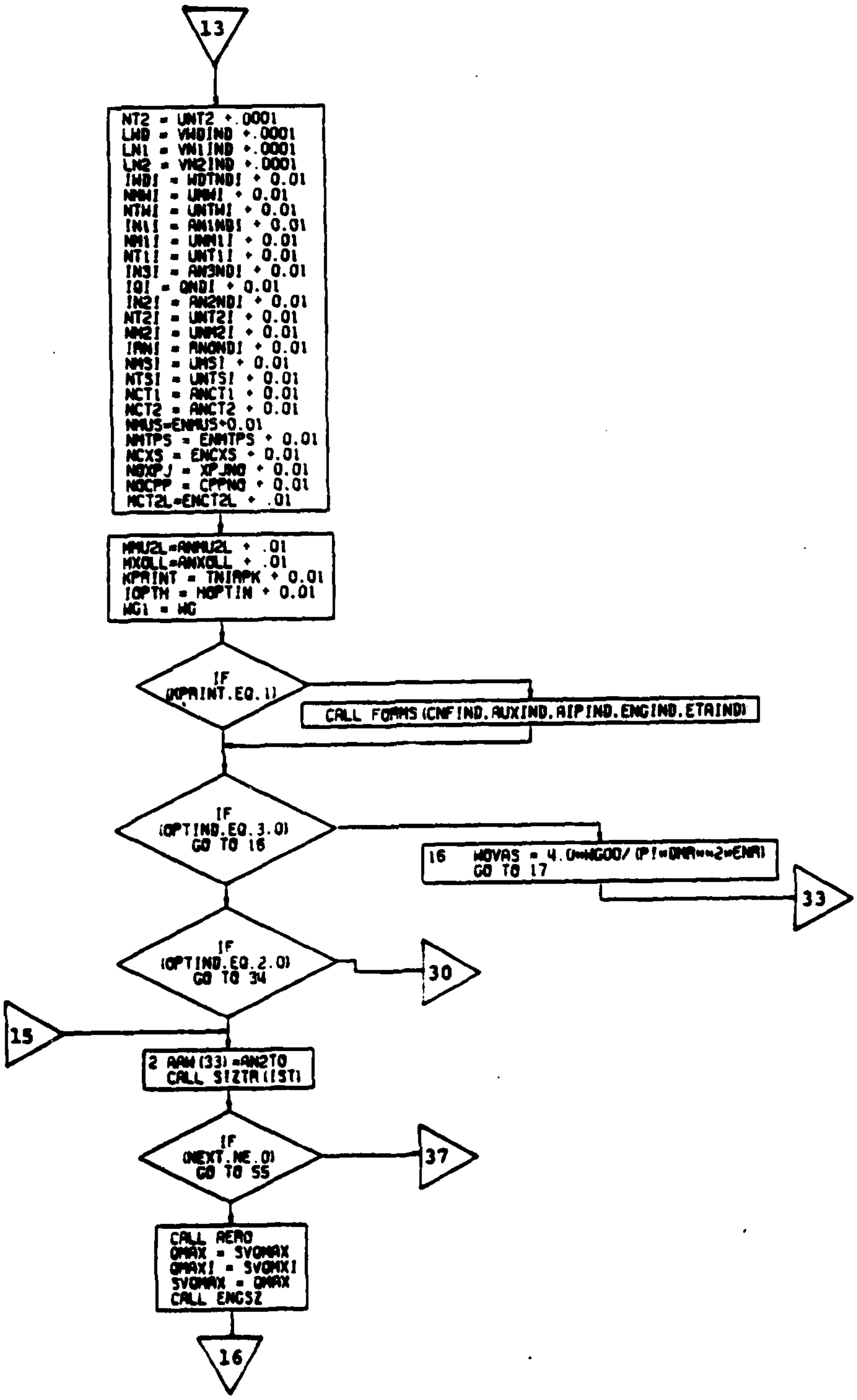


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 5 of 13)

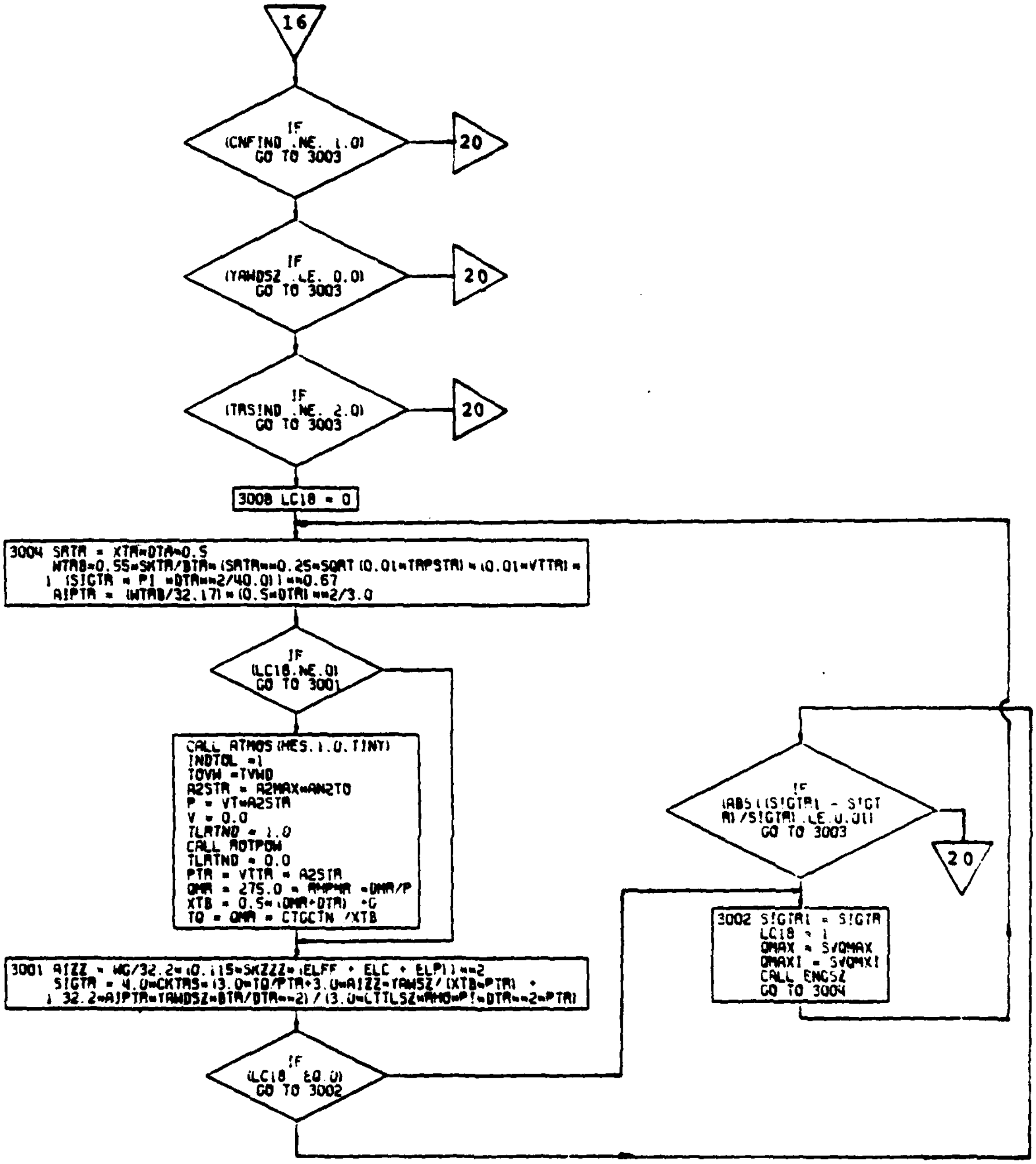


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 6 of 13)

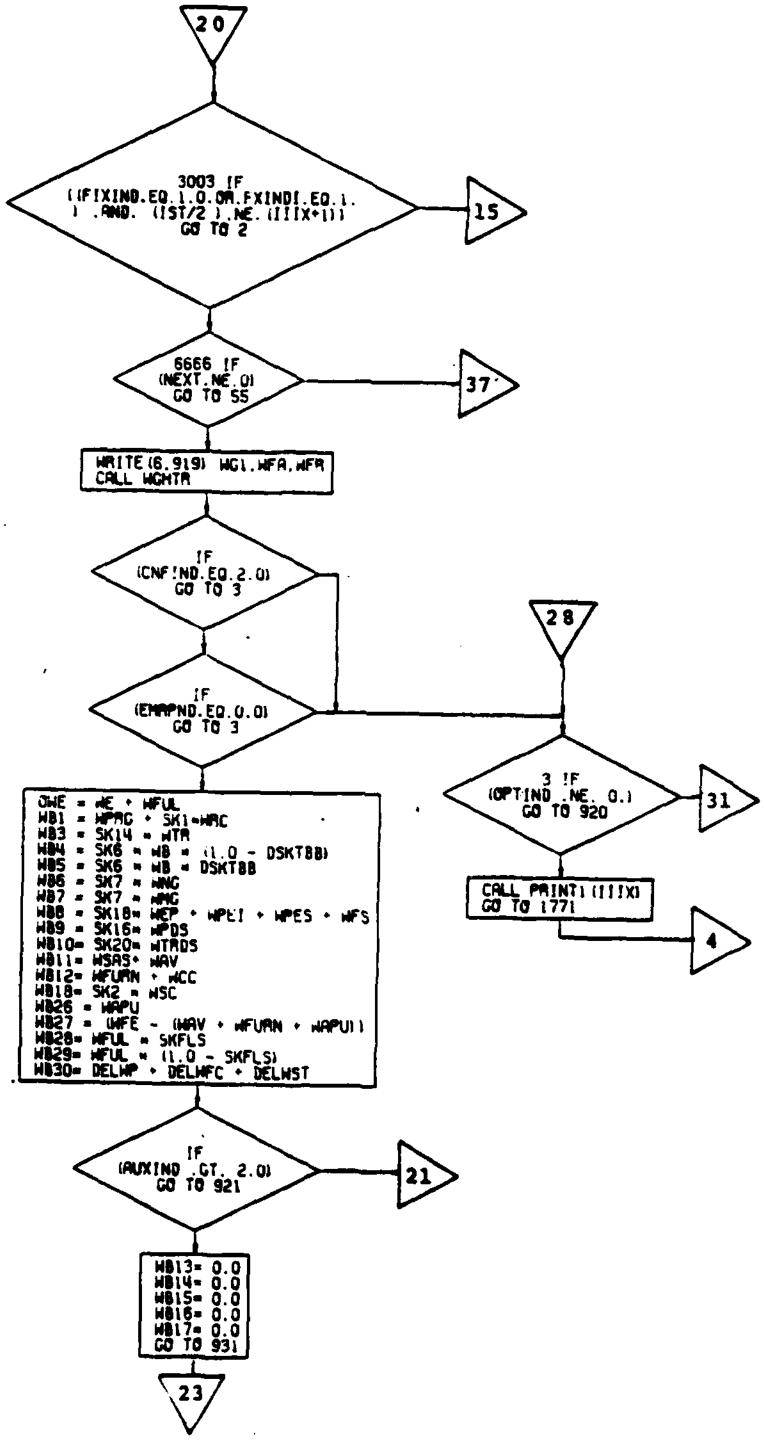


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 7 of 13)

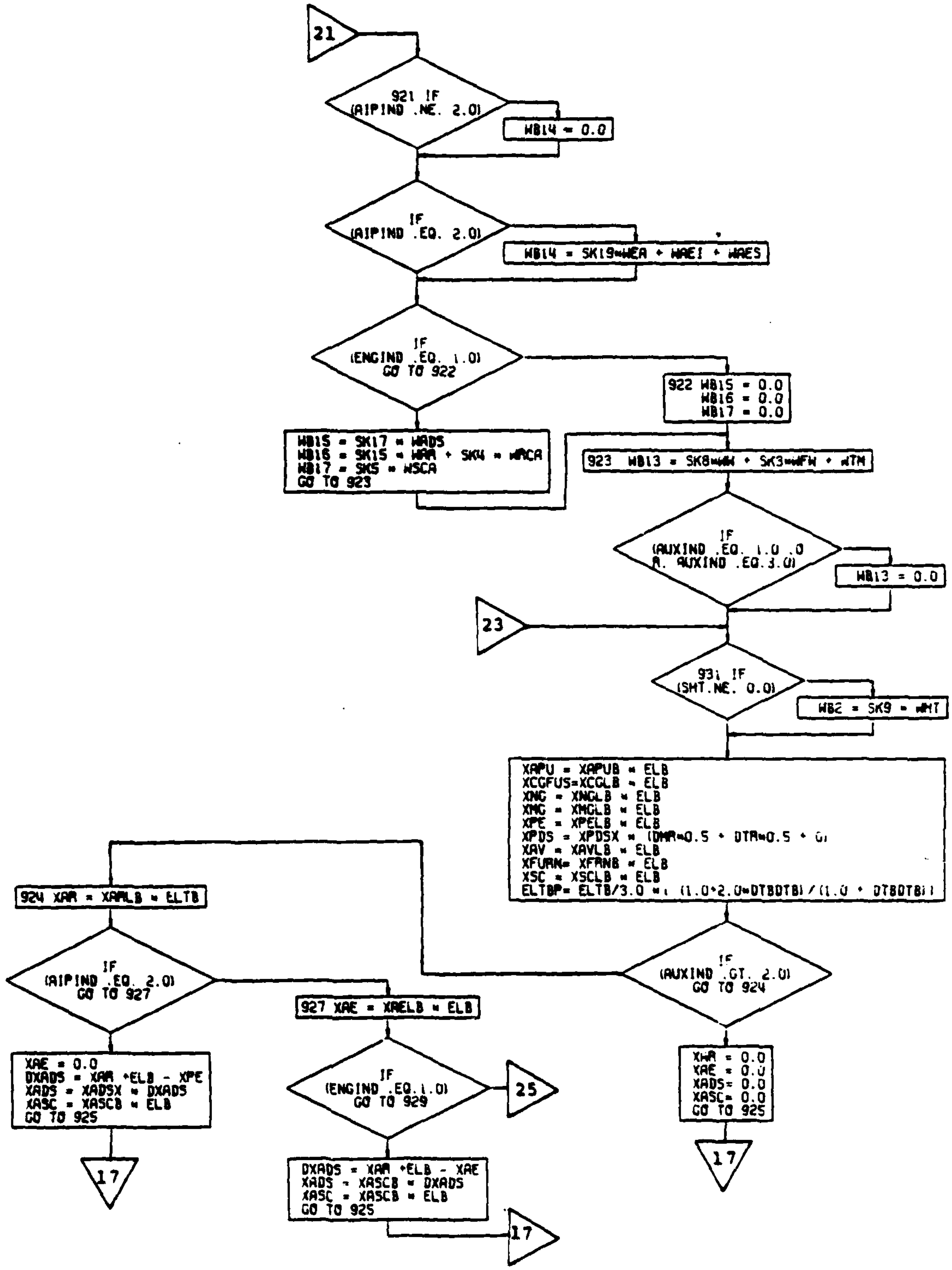


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 8 of 13)

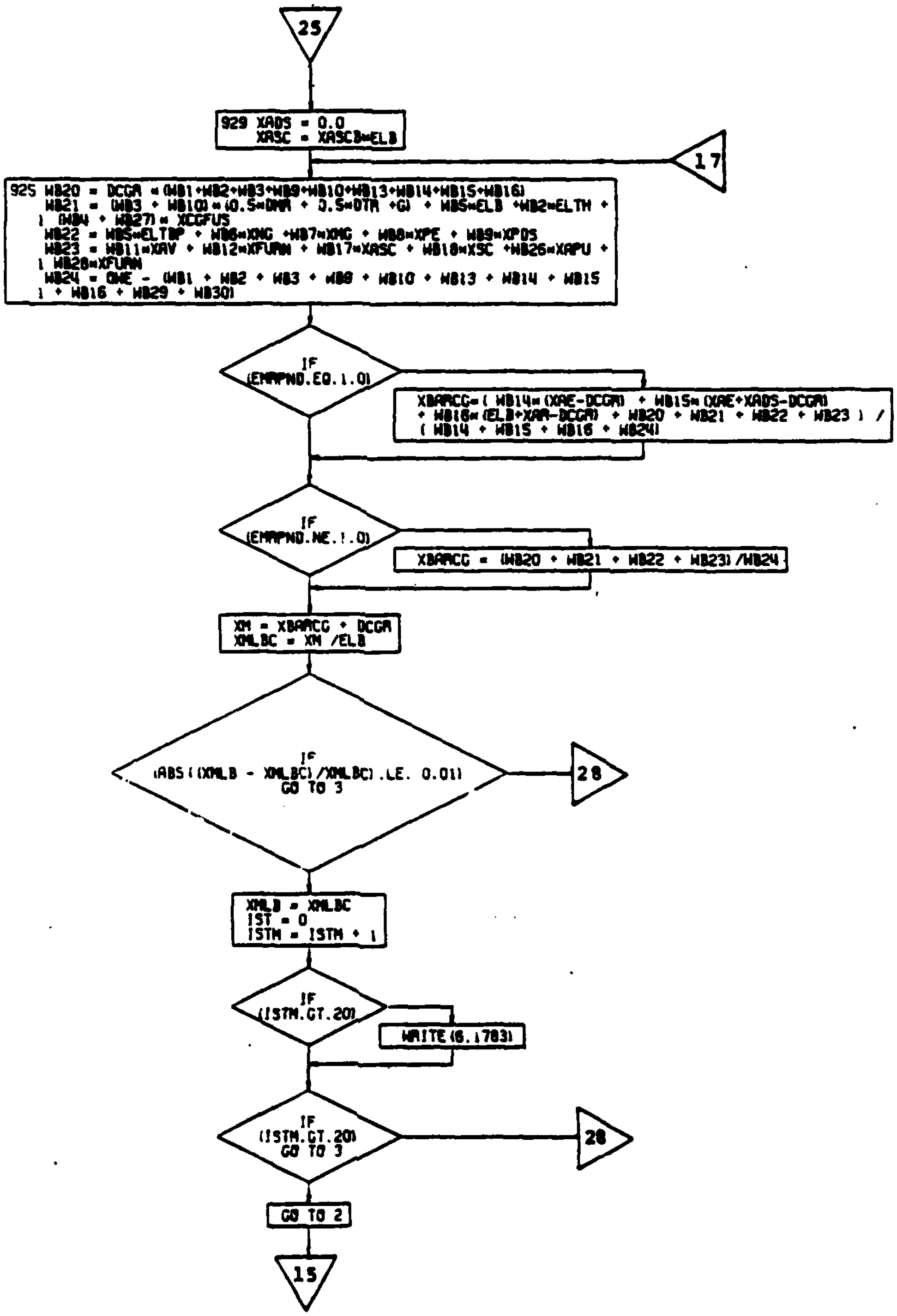


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 9 of 13)

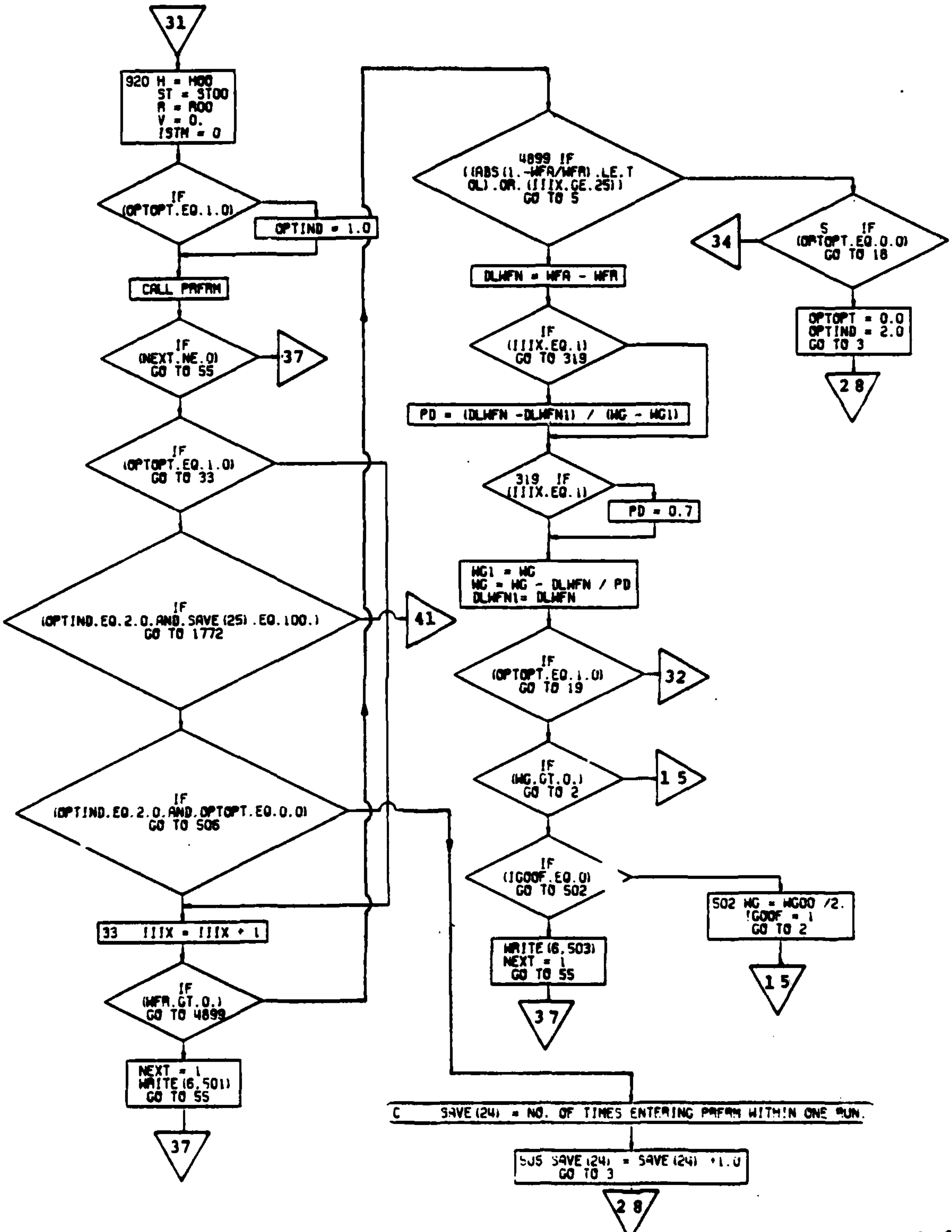


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 10 of 13)

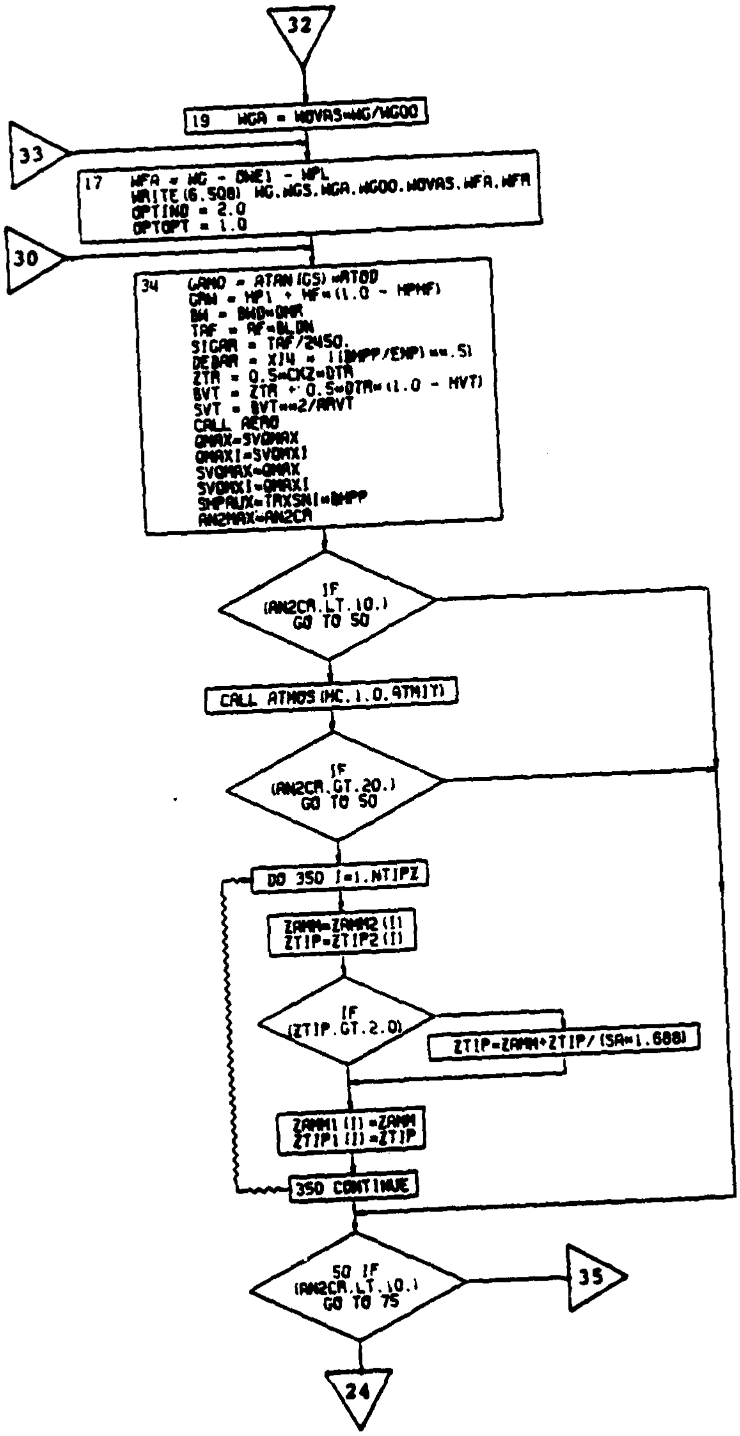


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 11 of 13)

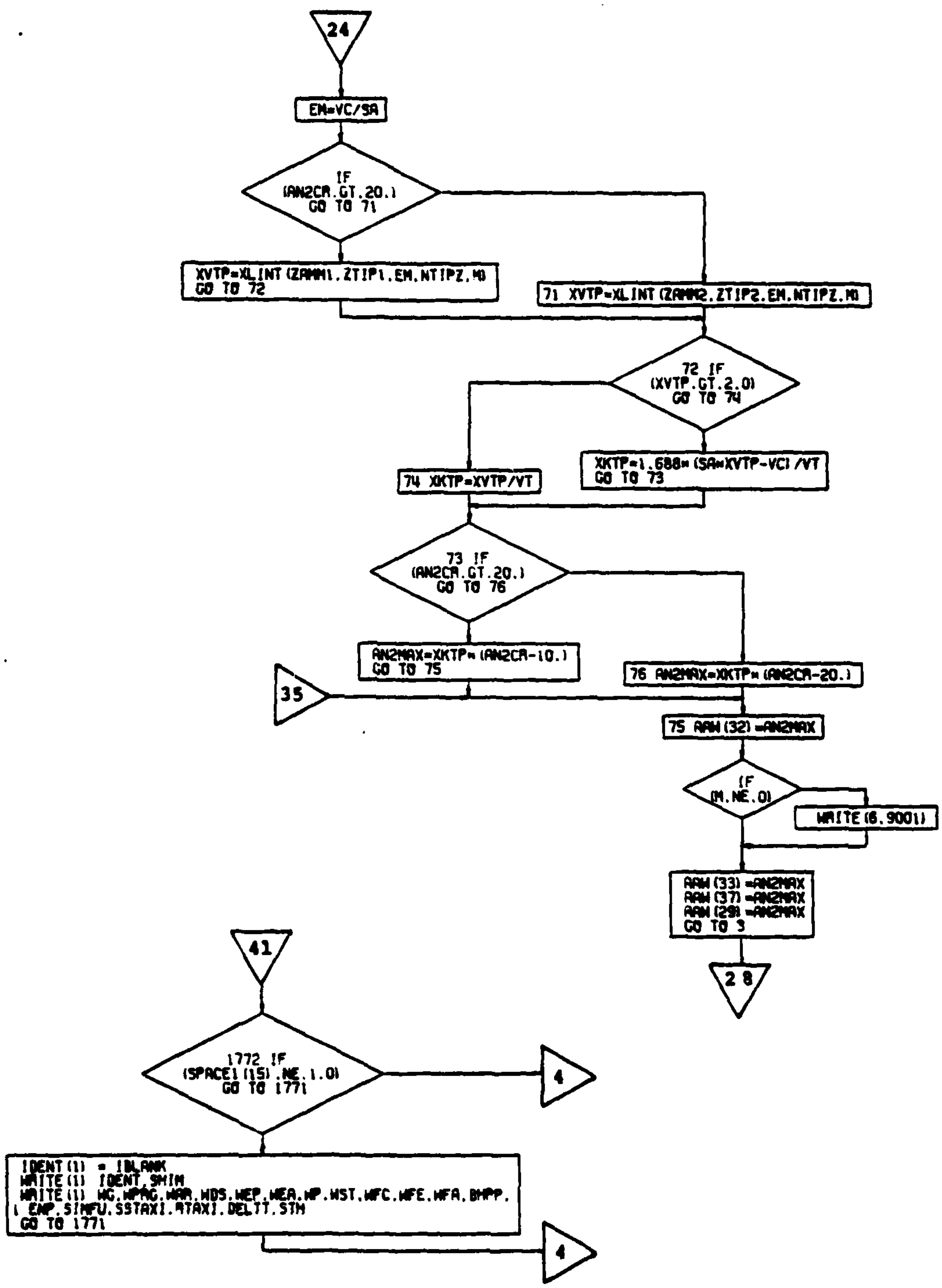


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 12 of 13)

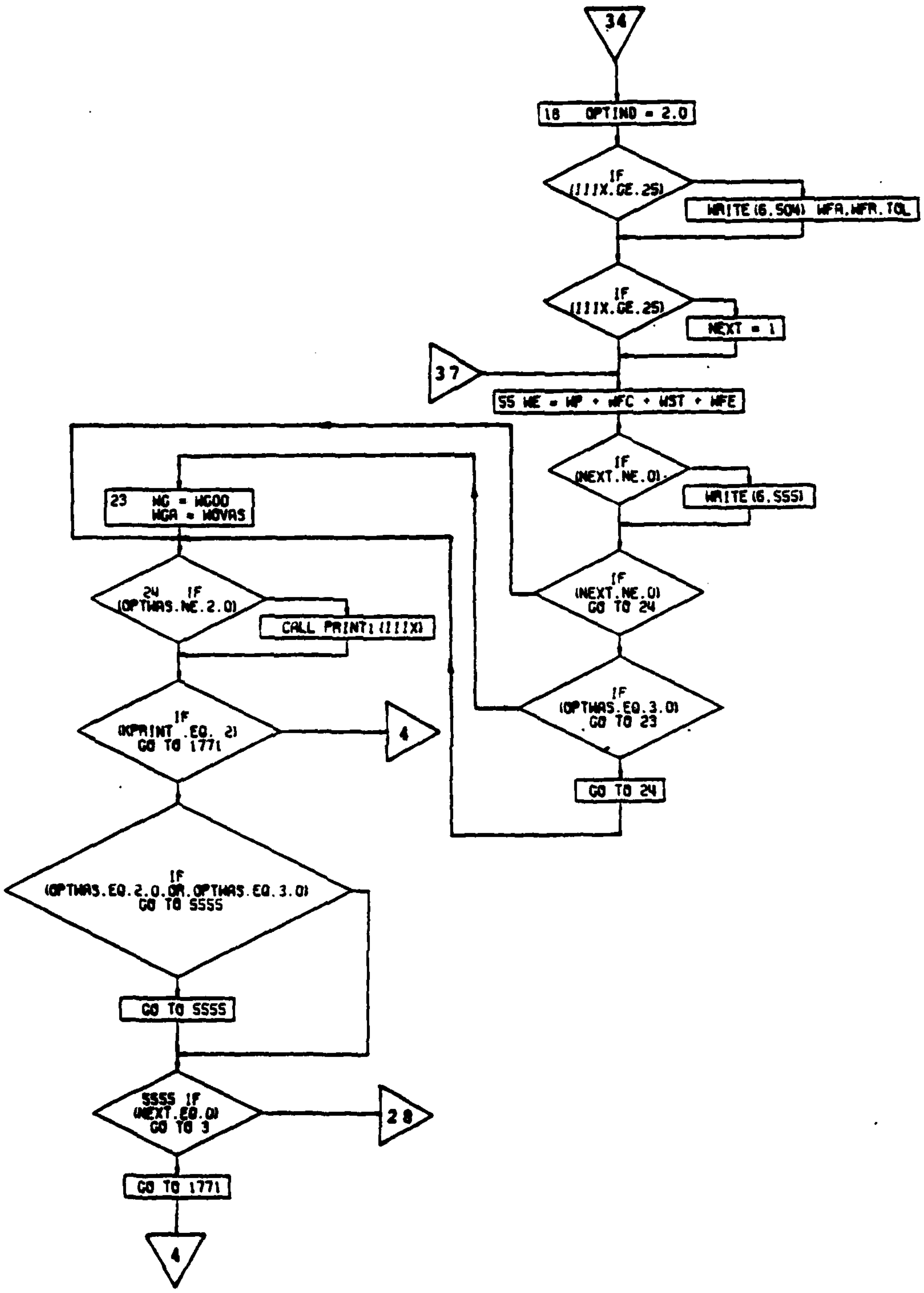


Figure 4-1. MAIN Control Loop Subroutine, Flow Chart (Part 13 of 13)

4.2 ATMOSPHERE SUBROUTINE

The atmosphere subroutine will calculate the atmospheric density, pressure, and temperature as a function of altitude. Three options included below are available. These are specified by means of an input indicator, ATMIND, which is input individually for the performance data and the engine sizing data. Thus, the atmosphere can be calculated differently for each segment of the flight profile and for the engine sizing.

The options are:

ATMIND = 0: Standard atmosphere

ATMIND = 1: Constant increment in temperature above standard temperature.

ATMIND = 2: Nonstandard temperature distribution as a function of altitude. Input locations 1650 -1670.

The flow chart for the atmosphere subroutine is shown in Figure 4-2.

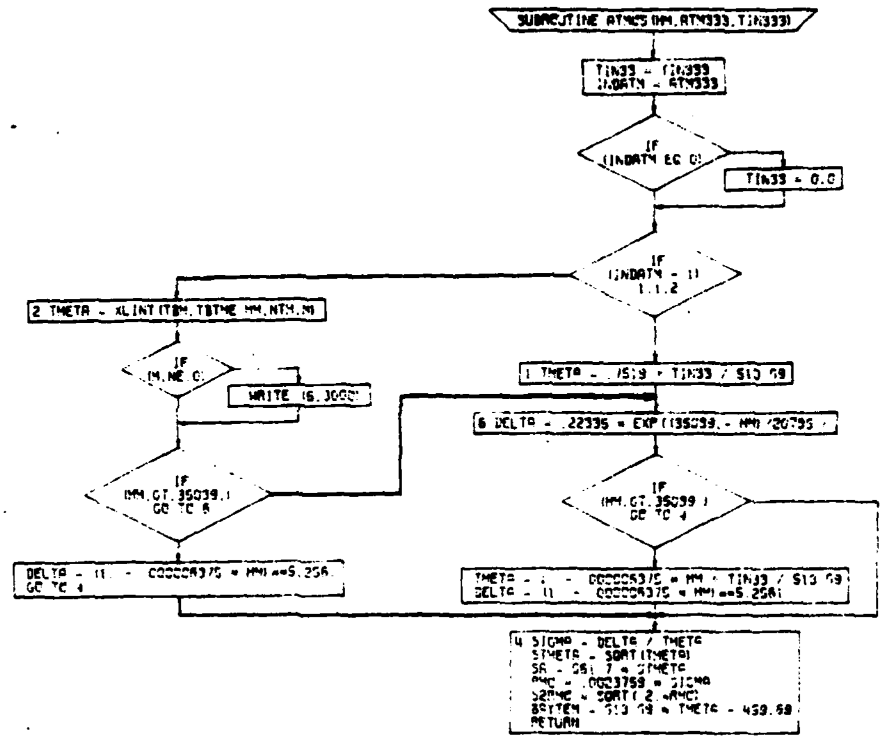


Figure 4-5. ATMOS Subroutine, Flow Chart

4.3 DRAG CALCULATIONS SUBROUTINE

The drag calculations subroutine uses the factors a_5 through a_9, as determined by the aerodynamics calculations subroutine to calculate the total drag of the helicopter. Besides parasite drag, in the case of compound or winged helicopters, total drag includes wing induced drag and rotor/wing interference drag, the latter being calculated using a simplified Prandtl Bi-Plane Theory approach. The total helicopter propulsive thrust coefficient (C_X) is calculated as a function of forward flight helicopter advance ratio (μ). The subroutine flow chart is shown in Figure 4-3.

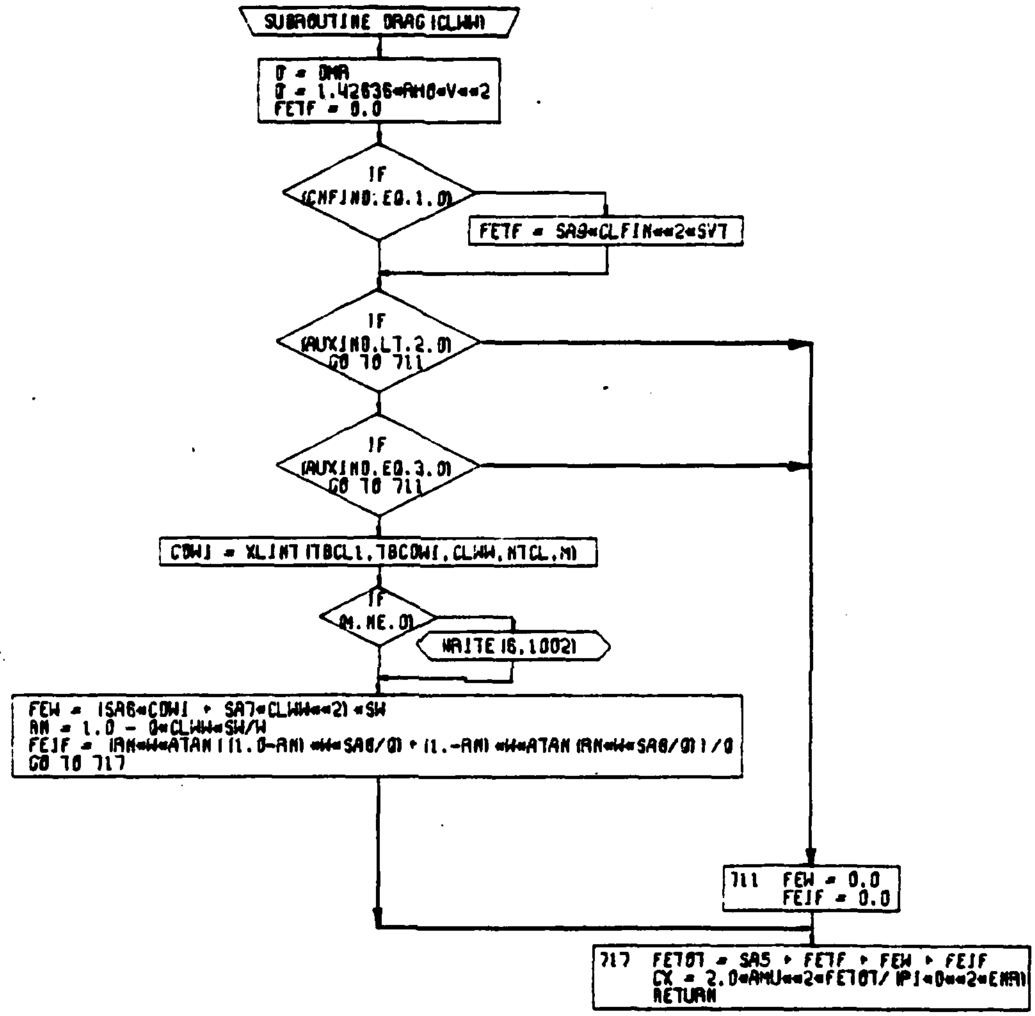


Figure 4-3. Drag Calculations (DRAG) Subroutine Flow Chart (Part 1 of 1).

4.4 ENGINE LIBRARY AND ENGINE CYCLE SUBROUTINES

The basic cycle performance data consists of tabulated values of four variables:

1. referred thrust or horsepower

   input locations 1326-1373

2. referred fuel flow

   input locations 1390-1437

3. referred gas generator shaft RPM

   input locations 1454-1501

4. referred power turbine shaft RPM

   input locations 1518-1565

For the primary engine cycles, these tables are functions of Mach number and turbine inlet referred temperature. For lift engine cycles, the tables are functions only of turbine inlet referred temperature. All data are in referred, normalized format as shown in Table 4-1.

The standard engine cycle library consists of forty-five different generalized engine cycles shown in Table 4-2. The data for each cycle is punched in card form, accessible for input with the remainder of the input data for a given case. Each cycle is numbered; and, to guard against selection of an incorrect cycle, the cycle number is checked against a similar number input to the program by the user.

The fuel flow of the basic engine cycle should correspond to the manufacturer's specification data. Adjustments to the fuel flow level may be made by means of the input multiplier, K_{FF}.

Because of the normalized, referred format, all data are valid for any ambient temperature, standard or nonstandard. With the exception of referred power, none of the tables are dependent upon power turbine speed. Usually $\frac{N_{II}}{N_{II_{OPT}}}$ Loc (1238), is set equal to 1.0 in order to determine $\frac{N_{II}}{N_{II_{MAX}}}$ through the relationship

TABLE 4-1
ENGINE CYCLE DATA FORMAT

VARIABLE	SYMBOL	REFERRED, NORMALIZED FORM
Thrust	F_N	$F_N/\delta F_N^*$
Power	SHP	$SHP/\delta\sqrt{\theta}SHP^*$
Gas Generator rpm	N_I	$N_I/\sqrt{\theta}N_I^*$
Power Turbine rpm	N_{II}	$N_{II}/\sqrt{\theta}N_{II}^*$
Fuel Flow	$\dot{W}_f$	$\dot{W}_f/\delta\sqrt{\theta}F_N^*$ $\dot{W}_f/\delta\sqrt{\theta}SHP^*$
Turbine Inlet Temperature	T	T/θ
Where:	* =	Max. Power Setting, Static, Sea Level, Standard Day
	θ =	Ambient Temperature (°R) Divided by 518.69°R
	δ =	Ambient Pressure (psia) Divided by 14.696 psia

$$\frac{N_{II}}{N_{II_{OPT}}} = 1.0 = \frac{\left(\frac{N_{II}}{N_{II_{MAX}}}\right)\left(\frac{N_{IIMAX}}{N_{II}^*}\right)}{(N_{II}/N_{II_{OPT}}\sqrt{\theta})} \quad \frac{1}{\sqrt{\theta}}$$

where $\frac{N_{IIMAX}}{N_{II}^*}$ is input into Loc (1223). If $\frac{N_{II}}{N_{II_{MAX}}}$ is determined to be an unsatisfactory value, greater than 1.0, then set $\frac{N_{II}}{N_{II_{MAX}}}=1.0$ for specific segment and calculate $\frac{N_{II}}{N_{II_{OPT}}}$. Changes in $\frac{N_{II}}{N_{II_{OPT}}}$ directly affects $\frac{N_{II}}{N_{II_{MAX}}}$ and indirectly affects operating tip speed through

$$V_{T\ operating} = \left(\frac{N_{II}}{N_{II_{MAX}}}\right)\left(\frac{N_{II_{MAX}}}{N_{II}^*}\right) V_T$$

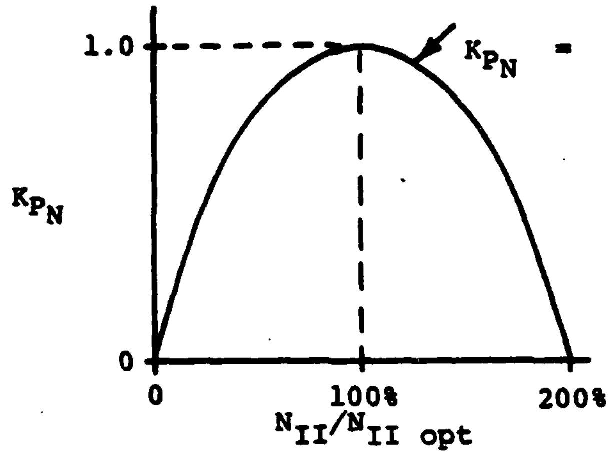
TABLE 4-2

HESCOMP ENGINE LIBRARY

			Engine Cycle Number	Maximum Turbine Inlet Tempera-ture - °R	Compressor Design Pressure Ratio	Fan Bypass Ratio
Auxiliary Independent Propulsion Engines	Primary Propulsion Engines	Turboshaft Engines	1	2600	13	
			2	2600	16	
			3	2900	13	
			4	2900	16	
			5	2900	19	
			6	3200	13	
			7	3200	16	
			8	3200	19	
			9	3200	22	
		Turbojet Engines	10	2600	13	
			11	2600	16	
			12	2900	13	
			13	2900	16	
			14	2900	19	
			15	3200	13	
			16	3200	16	
			17	3200	19	
			18	3200	22	
		Turbofan Engines	19,20,21	2600	16	2,4,6
			22,23,24	2600	20	2,4,6
			25,26,27	2900	16	2,4,6
			28,29,30	2900	20	2,4,6
			31,32,33	2900	24	2,4,6
			34,35,36	3200	16	2,4,6
			37,38,39	3200	20	2,4,6
			40,41,42	3200	24	2,4,6
			43,44,45	3200	28	2,4,6

where V_T is input Loc (0181). By setting N2IND = 2, Loc (1204), turboshaft engine power at nonoptimum N_{II} will be calculated by the program by multiplying power at optimum N_{II} by a correction factor, K_{PN}, which is a function of $N_{II}/N_{II_{MAX}}$. The factor K_{PN} is normally calculated by the program and obeys a second order relationship:

$$K_{P_N} = [1 - (1 - \frac{N_{II}}{N_{II\ opt}})^2]$$



Most, but not all, turboshaft engines will obey this relationship. For engine cycles whose performance is not properly represented by the above curve, the user may input a table of K_{PN} versus $N_{II}/N_{II_{OPT}}$ locations 1238-1257. The program uses inputs $N_{II}/N_{II_{MAX}}$ for each flight segment and $N_{II_{MAX}}/N_{II}$* for the engine cycle. The program uses this information to establish the value of $N_{II}/N_{II_{OPT}}$ for each point of flight.

By setting N2IND = 0 or 1, the program will assume that the power turbine is always operating at optimum speed and no correction will be applied. N2IND = 0 will simulate an engine cycle which is operating at optimum N_{II} and for which no upper limit has been placed on N_{II}. For many applications, this option will be perfectly adequate for preliminary sizing studies. The adequacy of this assumption can be determined by consideration of the following factors:

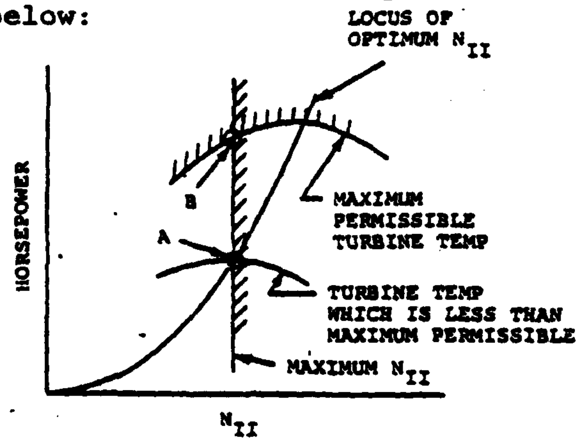
1. It may be desirable; e.g. as in the case of a slowed-rotor compound helicopter, to reduce the main rotor RPM in cruise flight.

2. For some applications this may, in turn, force the engine to operate at a very inefficient N_{II}. In general, the optimum N_{II} increases as output power increases relative to the maximum level.

N2IND = 1 will simulate operation of an engine cycle at optimum N_{II}, but with the restriction of a maximum value for N_{II}. This type of operation is characteristic of airplanes employing fixed pitch propellers. Care should be taken in using this option because it may lead to a significant reduction in power available as shown by the sketch below:

A = Point of operation for aircraft flying at optimum N_{II}, limited by $N_{II\ MAX}$. (N2IND = 1)

B = Point of operation for aircraft flying at nonoptimum N_{II}, limited by same $N_{II\ MAX}$. (N2IND = 2)



N2IND = 2 is similar to N2IND = 1 except the operational flying point is located at a nonoptimum N_{II}.

Limitations on engine cycle operation may be input to the program on any combination of the following:

- fuel flow WDTIND Loc (1201) =
  - 0. = no fuel flow cutoff
  - 1. = fuel flow cutoff specified by W_{MAX}/W^* Loc (1220).
- gas generator speed, N1IND Loc (1202) =
  - 0. = no gas generator speed cutoff
  - 1. = gas generator speed cutoff specified by $\frac{N_{I\ MAX}}{N_{I*}}$ Loc (1221)
- gas generator referred RPM, N1θIND Loc (1203) =
  - 0. = no referred RPM cutoff
  - 1. = referred RPM cutoff specified by

    Loc (1222)
- output shaft speed N2IND Loc (1204) =
  - 0. = no output shaft speed cutoff
  - 1. = output shaft speed cutoff specified by optimum Loc (1223).
  - 2. = output shaft speed cutoff specified by nonoptimum Loc (1233).

- torque, QIND Loc (1205) =
  - 0. = no torque limit
  - 1. = torque limit imposed on main and tail rotor transmission specified by Q_{MAX}/Q^* Loc (1224).
  - 2. = torque limit imposed on auxiliary propulsion transmission specified by Q_{MAX}/Q^* Loc (1224).

Engine ratings (power settings) are dictated by turbine temperature. Five discrete values of that parameter are input for the primary engine cycles, one for each of the following power settings: maximum, military, normal, flight idle, and ground idle.

The program will print out, during the mission, the value of turbine temperature and a code that designates which condition is governing the engine performance at that point: power or thrust required, turbine temperature, torque limit, N_I limit, referred N_I limit, N_{II} limit, or fuel flow limit.

Manufacturer's data on some engines show significant variations in both referred power ($shp/\delta\sqrt{\theta}$) and lapse rate with respect to changes in altitude. These variations are due to Reynolds' number effects. It has been found that these effects can be accounted for by means of a multiplicative factor on power available which is a function of the Reynolds number based on compressor inlet conditions, compressor blade geometry, and tip speed. Figure 4-4 shows a typical curve for a real engine. The correction factor K_{PR} is input to the program as a function of the Reynolds' parameter

$$\frac{N_I}{N_I^*}\,\frac{D}{\nu_1} \, .$$

The tabular input of power, fuel flow, N_I, and N_{II} for engines which require Reynolds number corrections should be input to the program at a nominal fixed value of the Reynolds number parameter. The K_{PR} correction factor will then give the power at other values of the Reynolds number parameter. In the example shown in Figure 4-4, the nominal value of the parameter was chosen as 9000 seconds/foot.

The referred N_I limit is a constraint on the value of $N_I/\sqrt{\theta_1}$ where θ_1 is the temperature ratio at the compressor face. This limit simulates a restriction on compressor speed. The user inputs a maximum value of $N_I/N_I^*\sqrt{\theta_1}$.

The engine dry weight and dimensions are calculated by means of the input parameters k_3, k_{3_I}, k_4, k_{4_I}, ξ_4 and ξ_{4_I}:

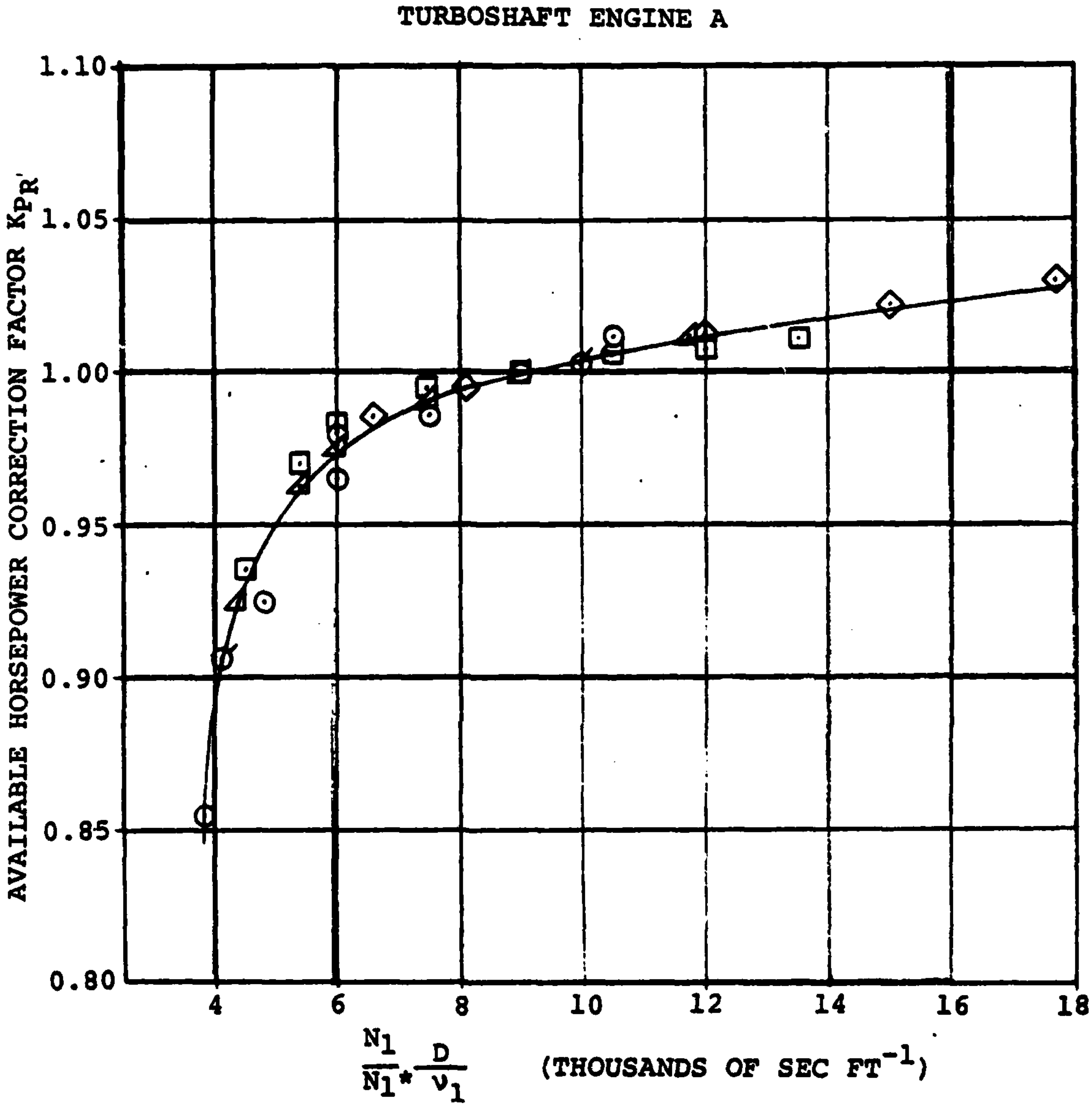


Figure 4-4. Typical Reynolds Number Correction Factor for a Turboshaft Engine Cycle.

Primary engines

$$\text{weight (lb)} = k_3 \frac{SHP^*}{N_P} + k_4$$

$$\text{diameter (ft)} = \xi_4 \left[\frac{SHP^*}{N_P}\right]^{1/2}$$

N_P = number of primary engines

Auxiliary Independent Engines

$$\text{weight (lb)} = k_{3_I} \frac{F_N^*}{N_{P_i}} + k_{4_I} \text{ or } k_{3_I} \frac{SHP^*{}_i}{N_{P_i}} + k_{4_I}$$

$$\text{diameter (ft)} = \xi_{4_I} \left[\frac{F_N^*}{N_{P_i}}\right]^{1/2} \text{ or } \xi_{4_I} \left[\frac{SHP^*{}_i}{N_{P_i}}\right]^{1/2}$$

N_{P_i} = number of independent auxiliary engines

It should be noted that auxiliary independent engine input data can be created from the engine cycle library data simply by the input of the applicable engine cycle IBM card deck, preceded and followed by a "66666" card. Nonstandard auxiliary independent engine performance is input using the sheet provided for that purpose.

Figures 4-5 through 4-12 are flow charts of the engine cycle subroutines. The purpose of these subroutines is described in Table 3-1 in Section 3.0 of this document.

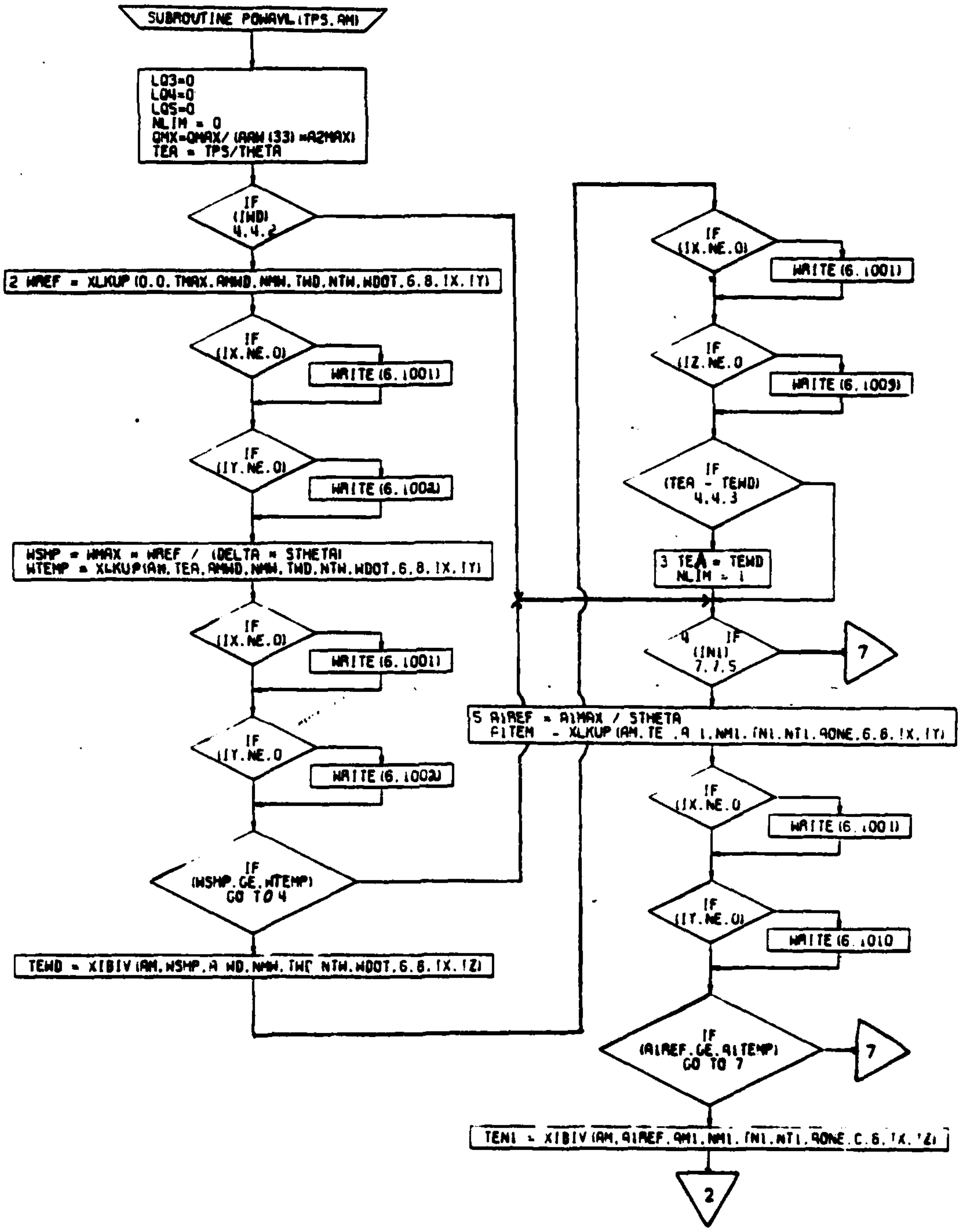


Figure 4-5. POWAVL Subroutine, Flow Chart (Part 1 of 5)

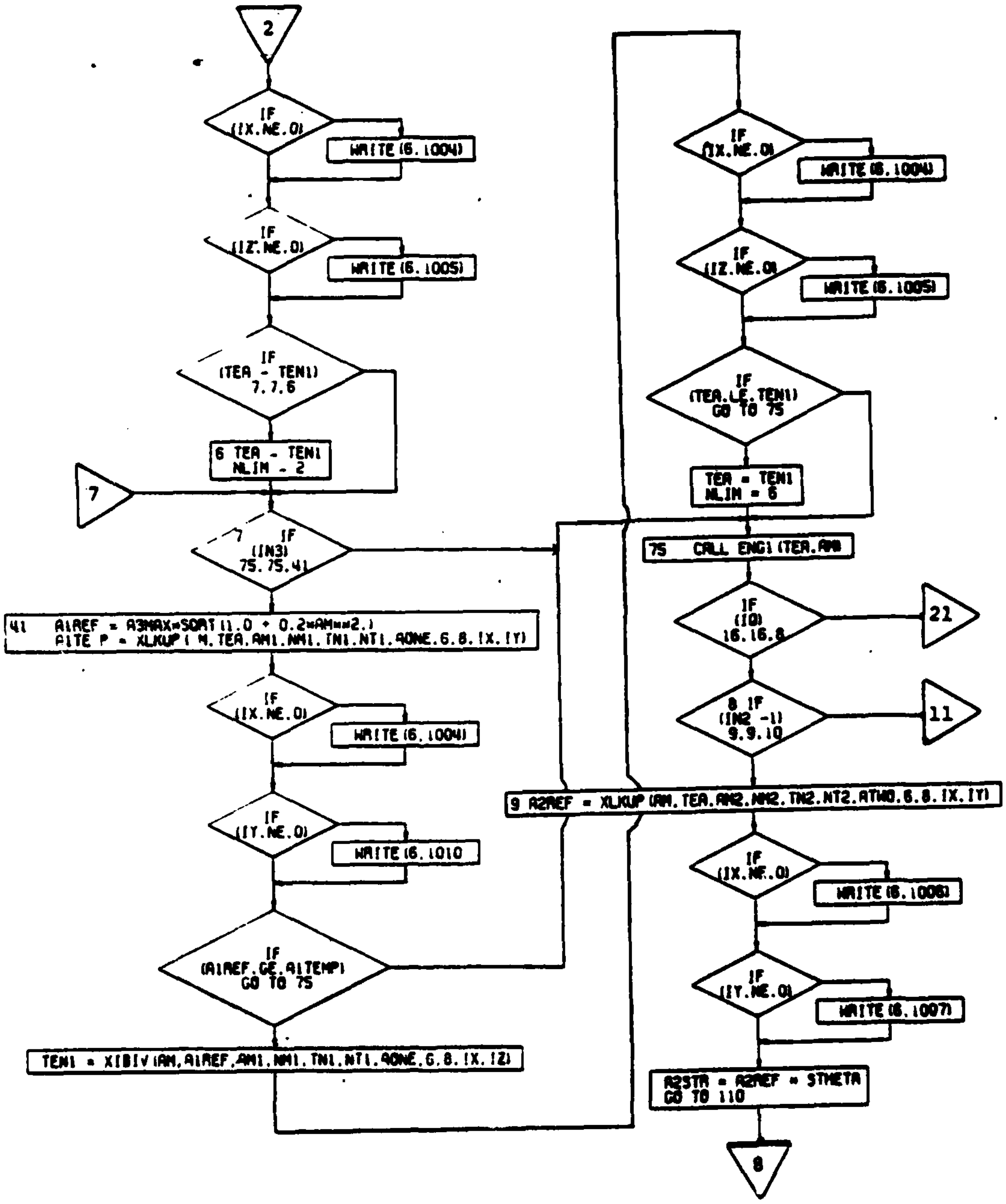


Figure 4-5. POWAVL Subroutine, Flow Chart (Part 2 of 5)

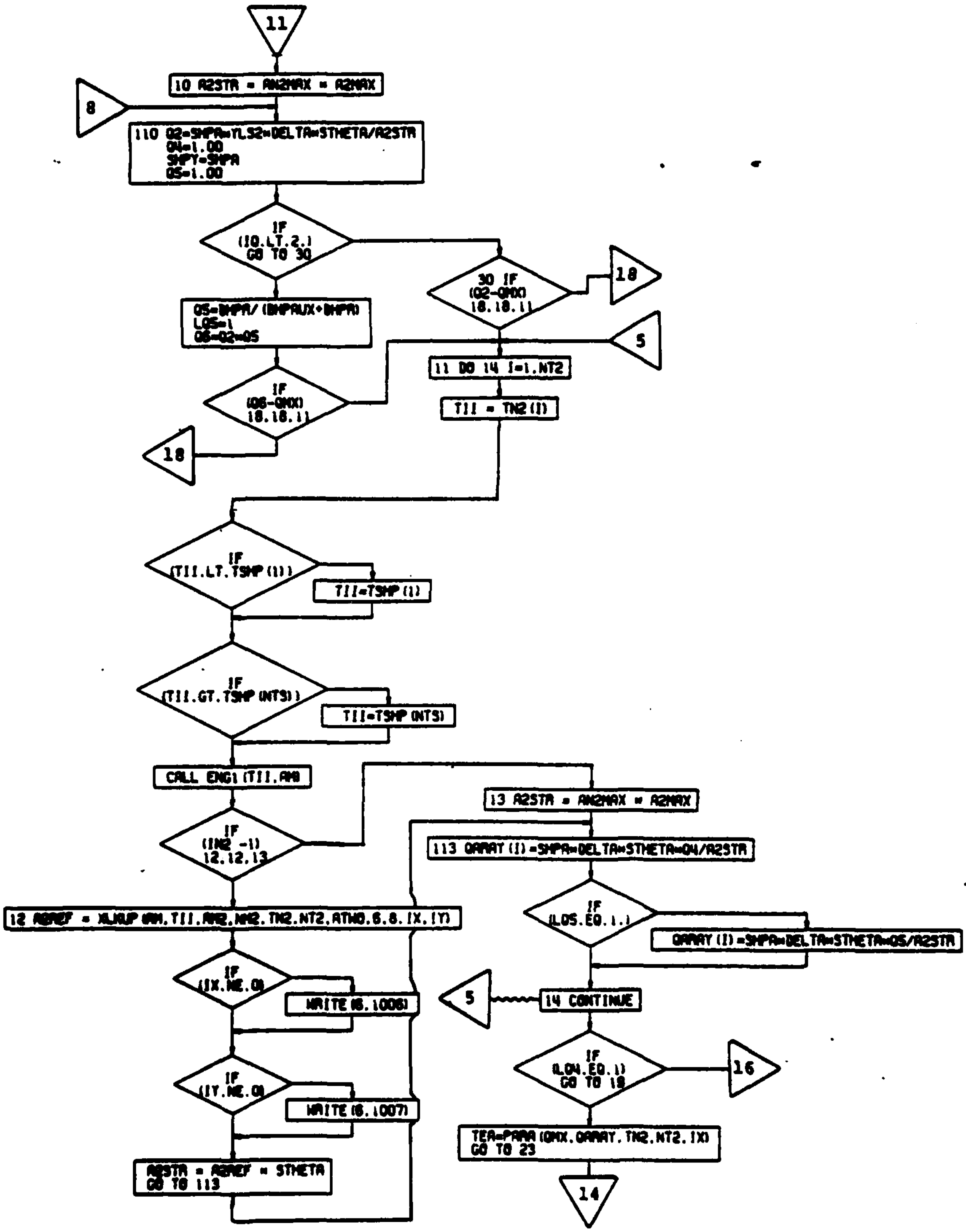


Figure 4-5. POWAVL Subroutine, Flow Chart (Part 3 of 5)

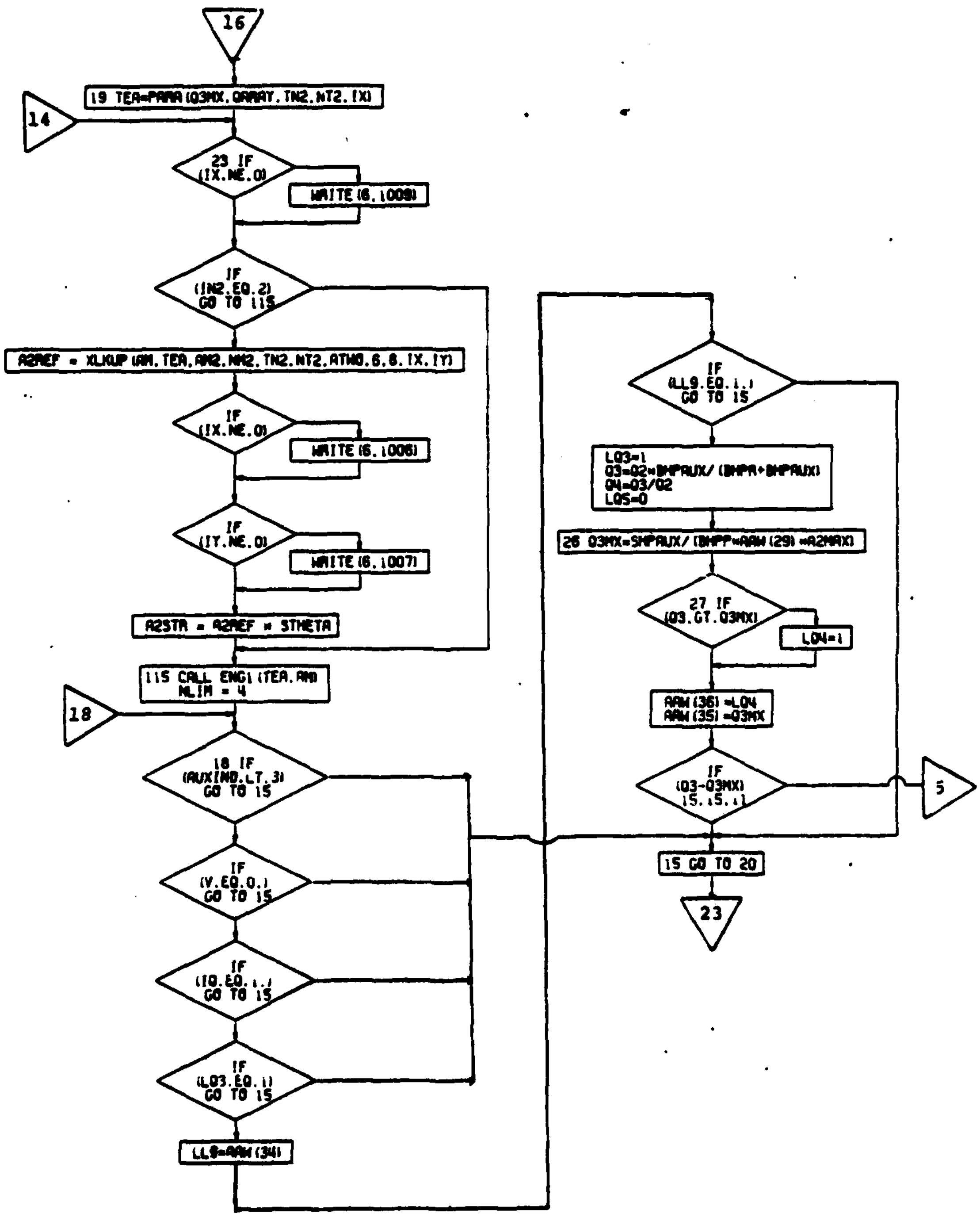


Figure 4-5. POWAVL Subroutine, Flow Chart (Part 4 of 5)

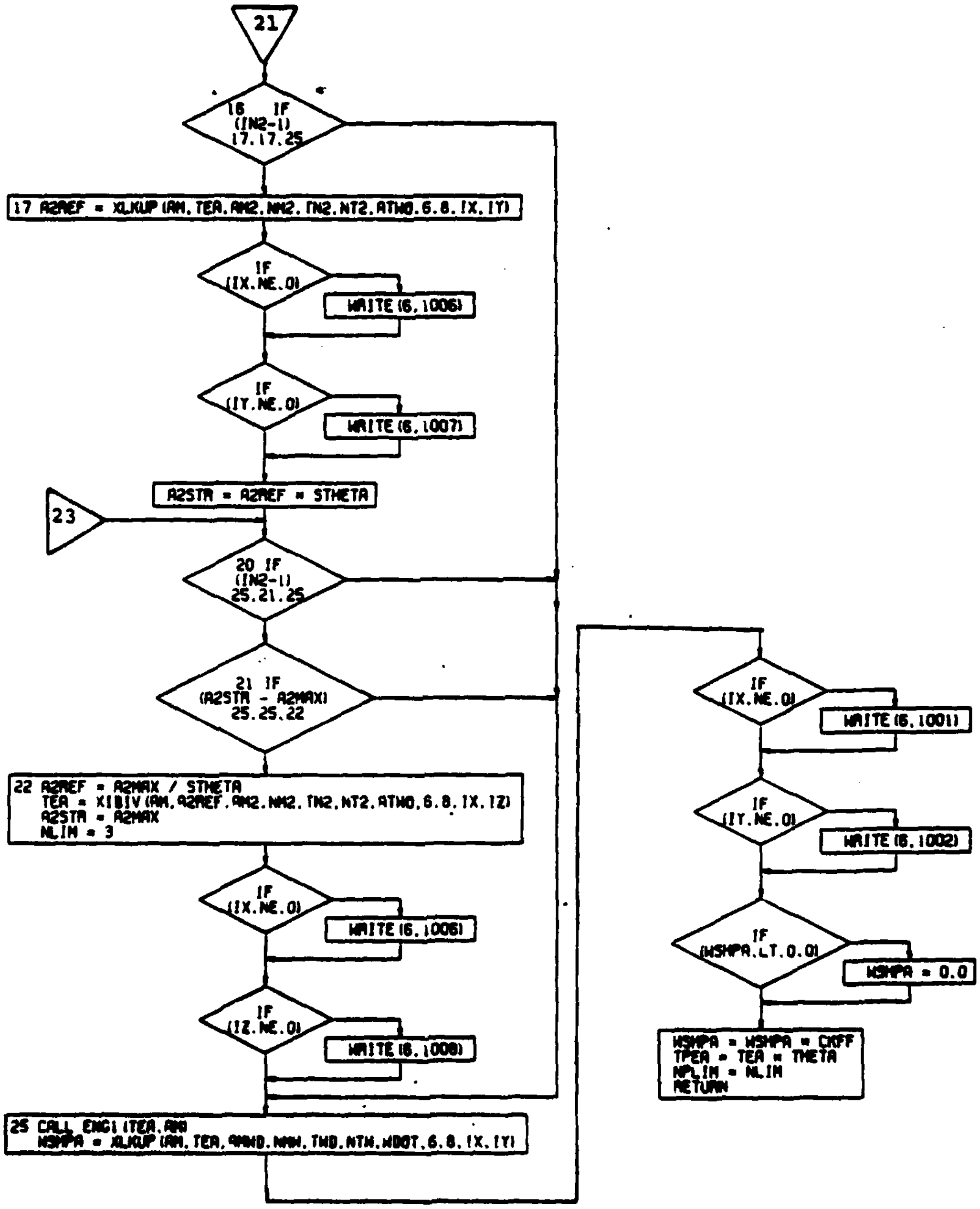


Figure 4-5. POWAVL Subroutine, Flow Chart (Part 5 of 5)

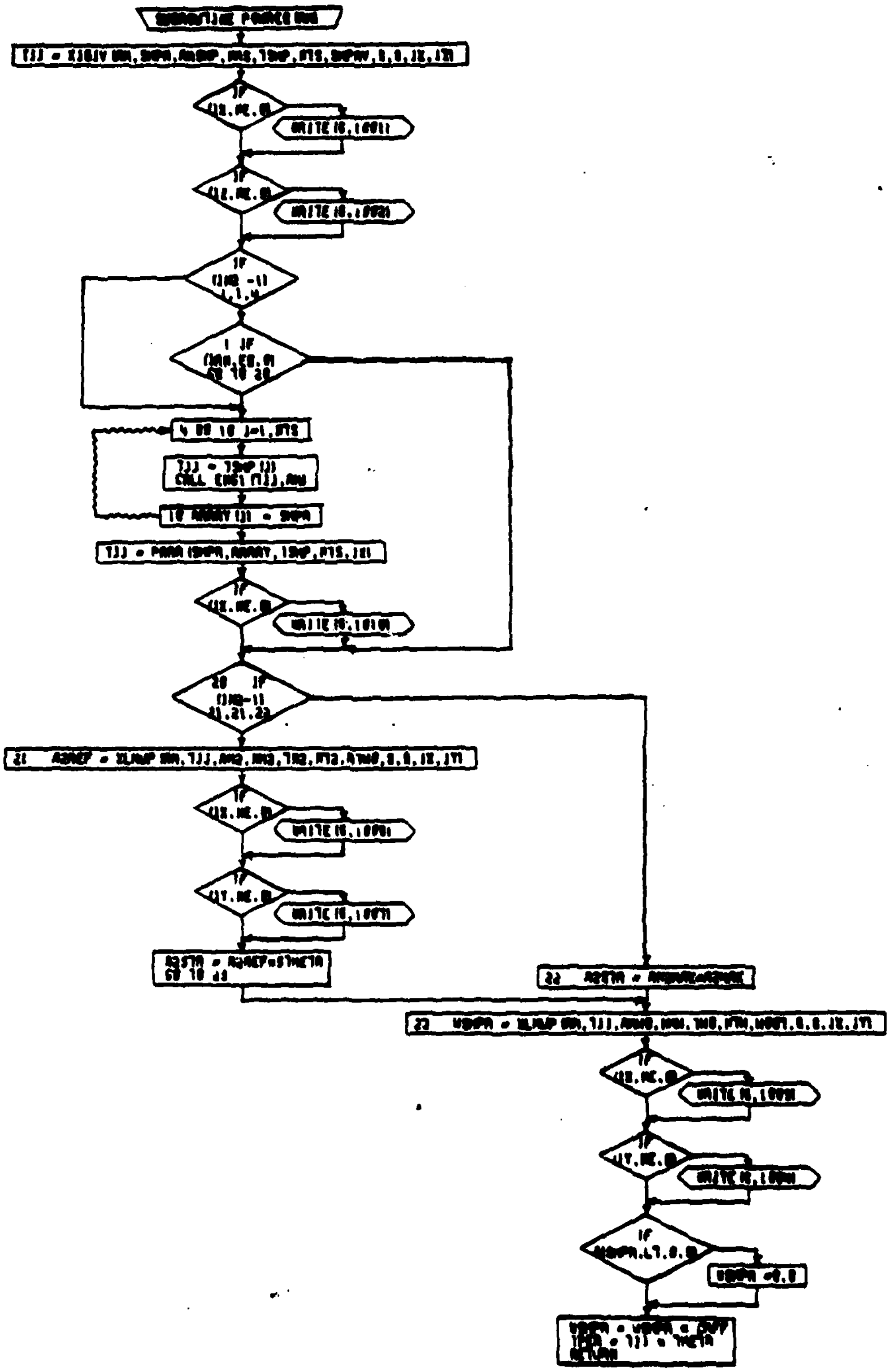


Figure 4-6. POWREQ Subroutine, Flow Chart.

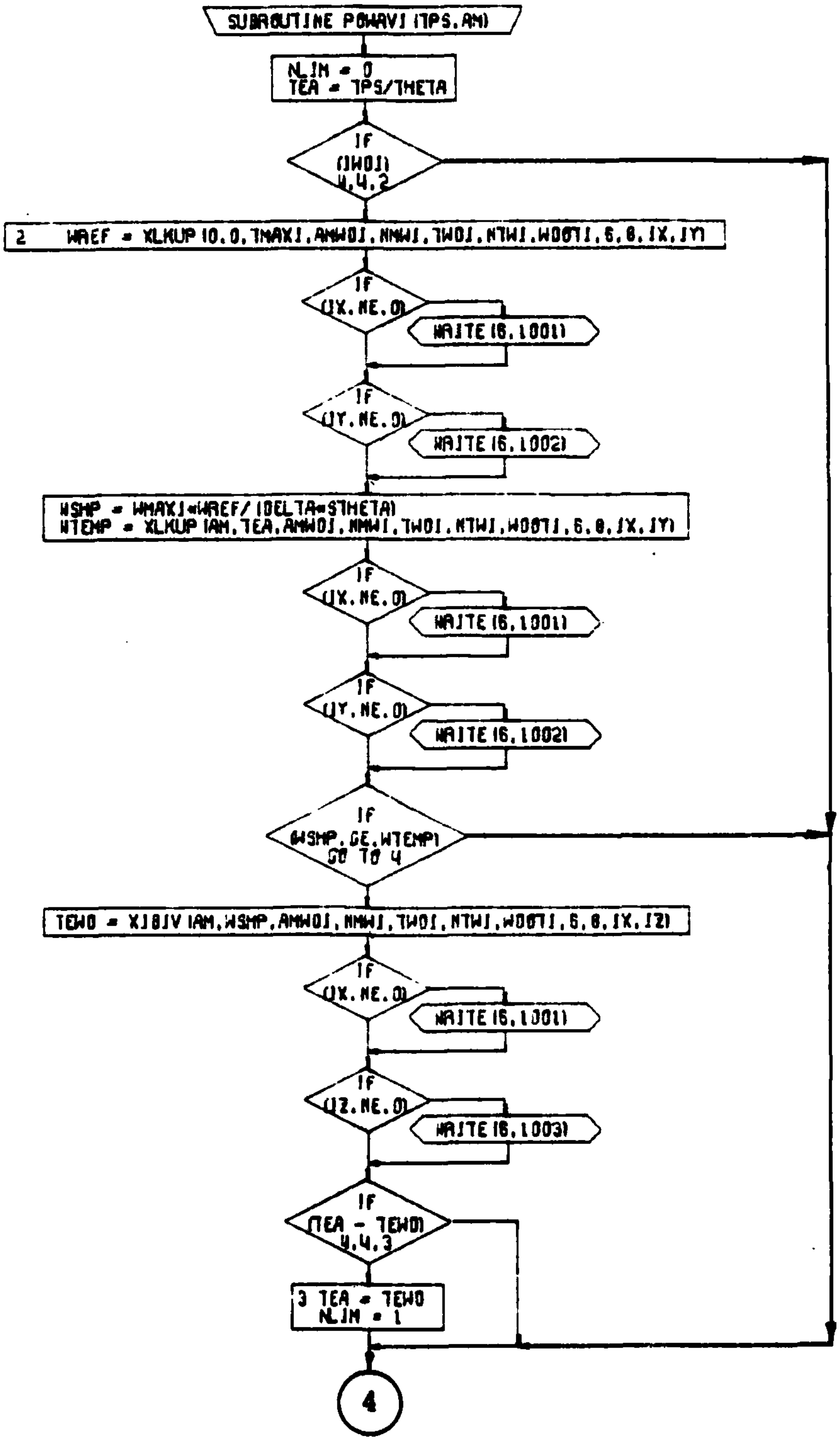


Figure 4-7. POWAVI Subroutine Flow Chart (Part 1 of 7).

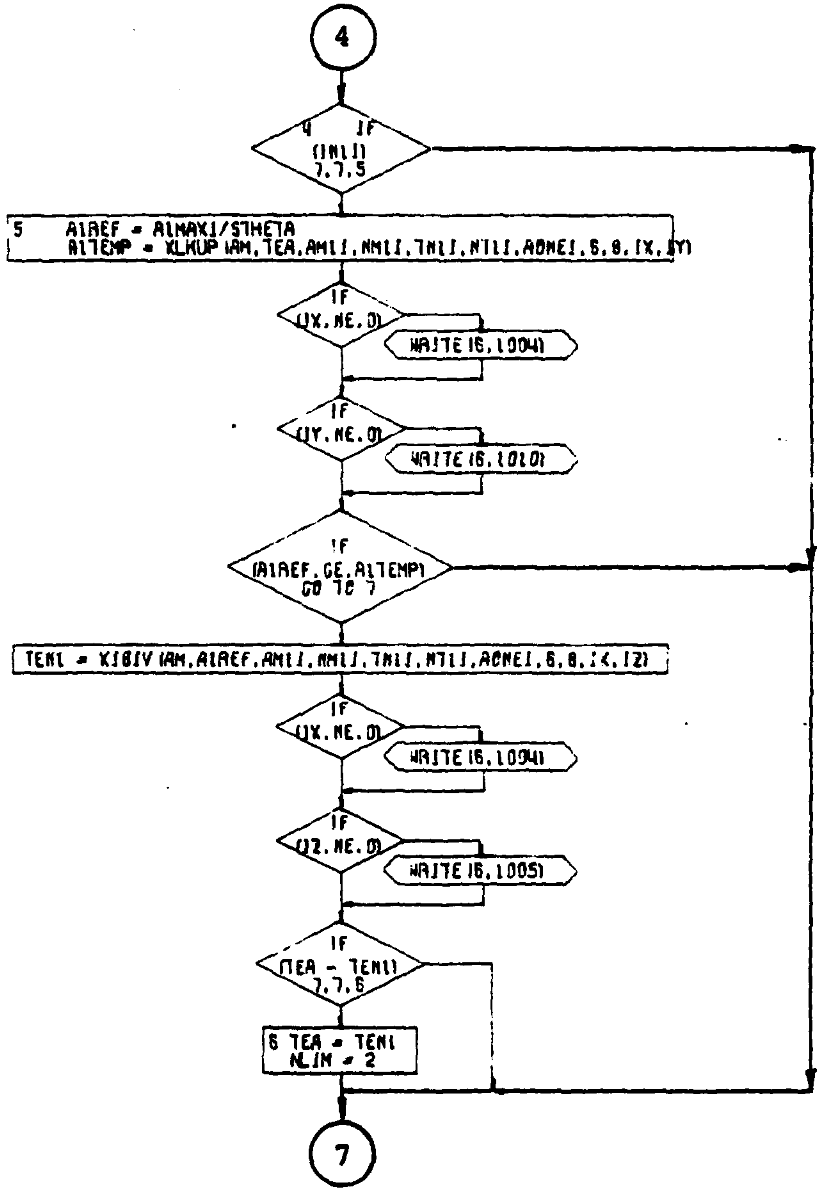


Figure 4-7. POWAVI Subroutine Flow Chart (Part 2 of 7).

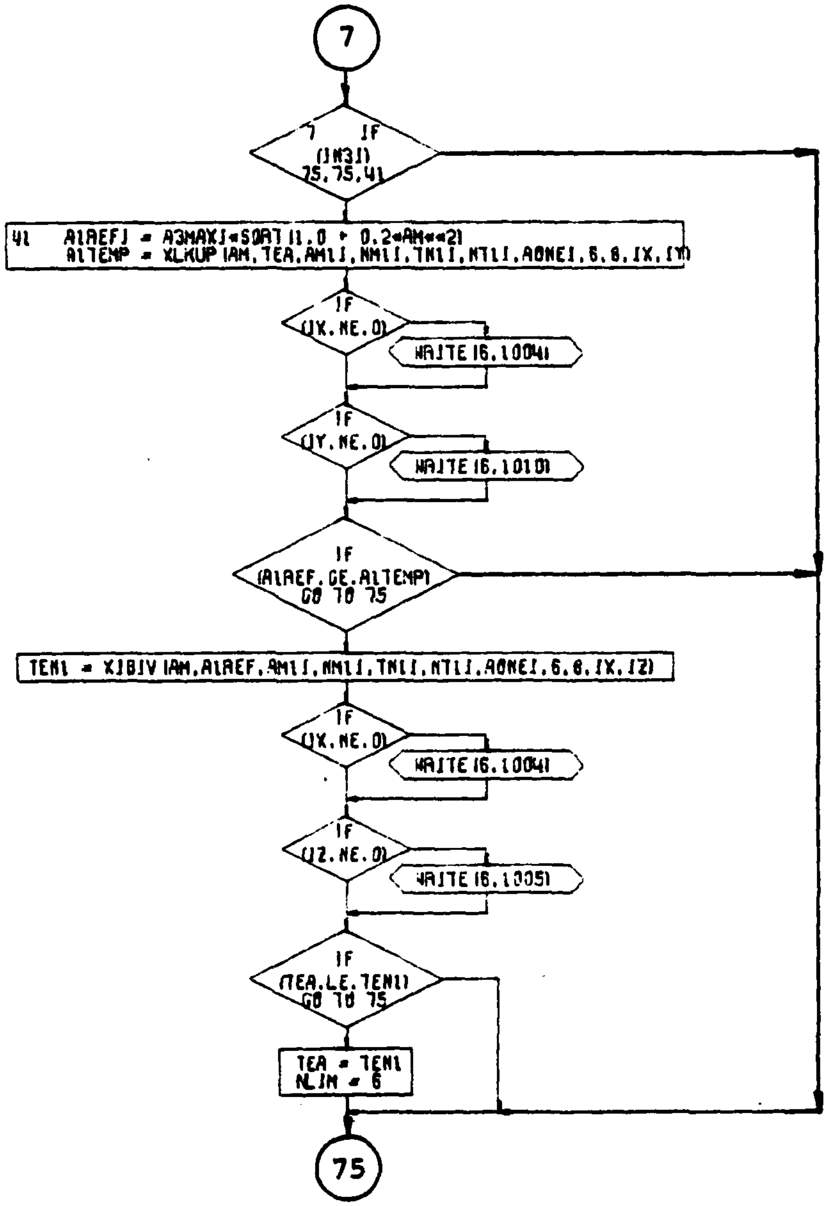


Figure 4-7. POWAVI Subroutine Flow Chart (Part 3 of 7).

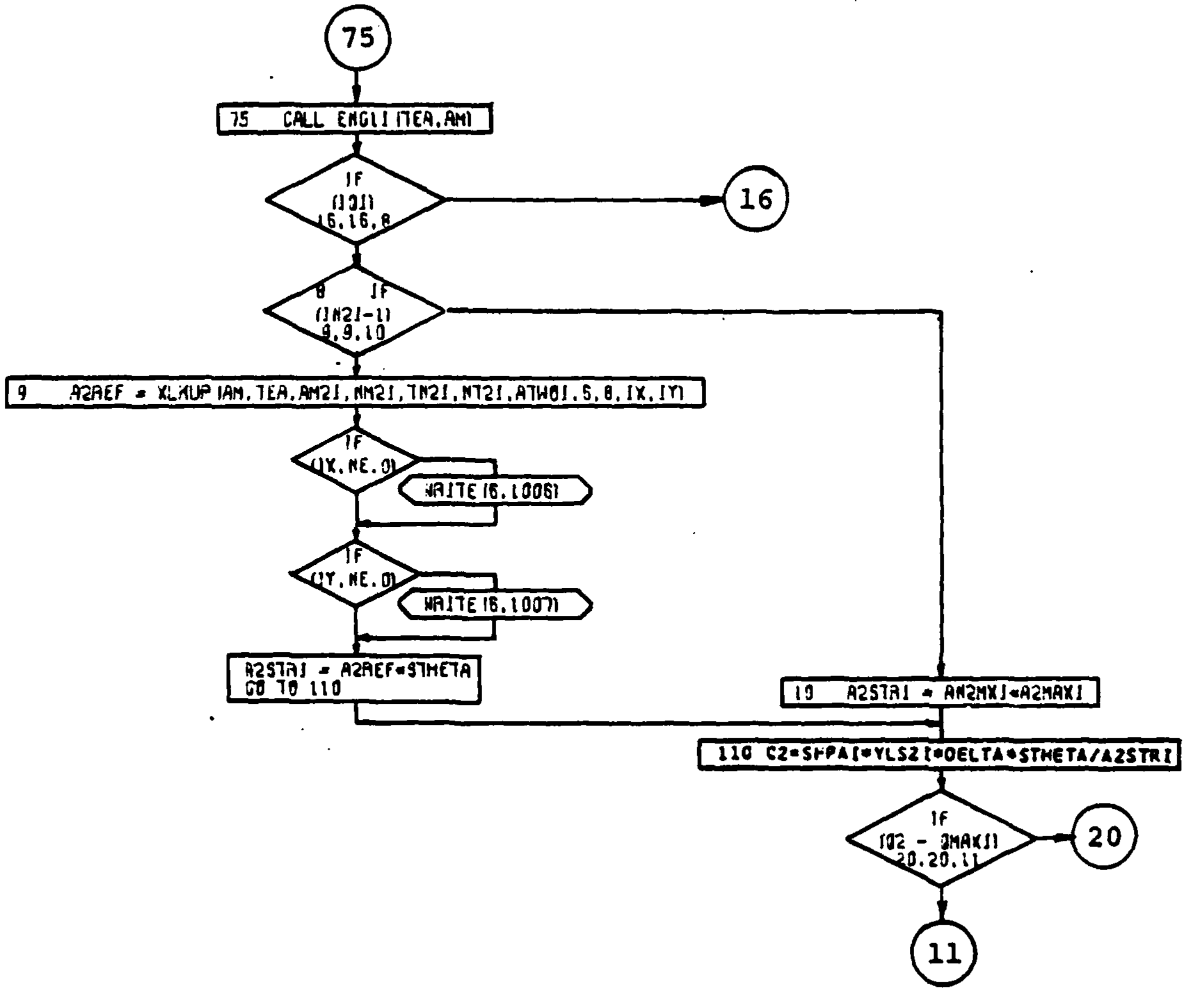


Figure 4-7. POWAVI Subroutine Flow Chart (Part 4 of 7).

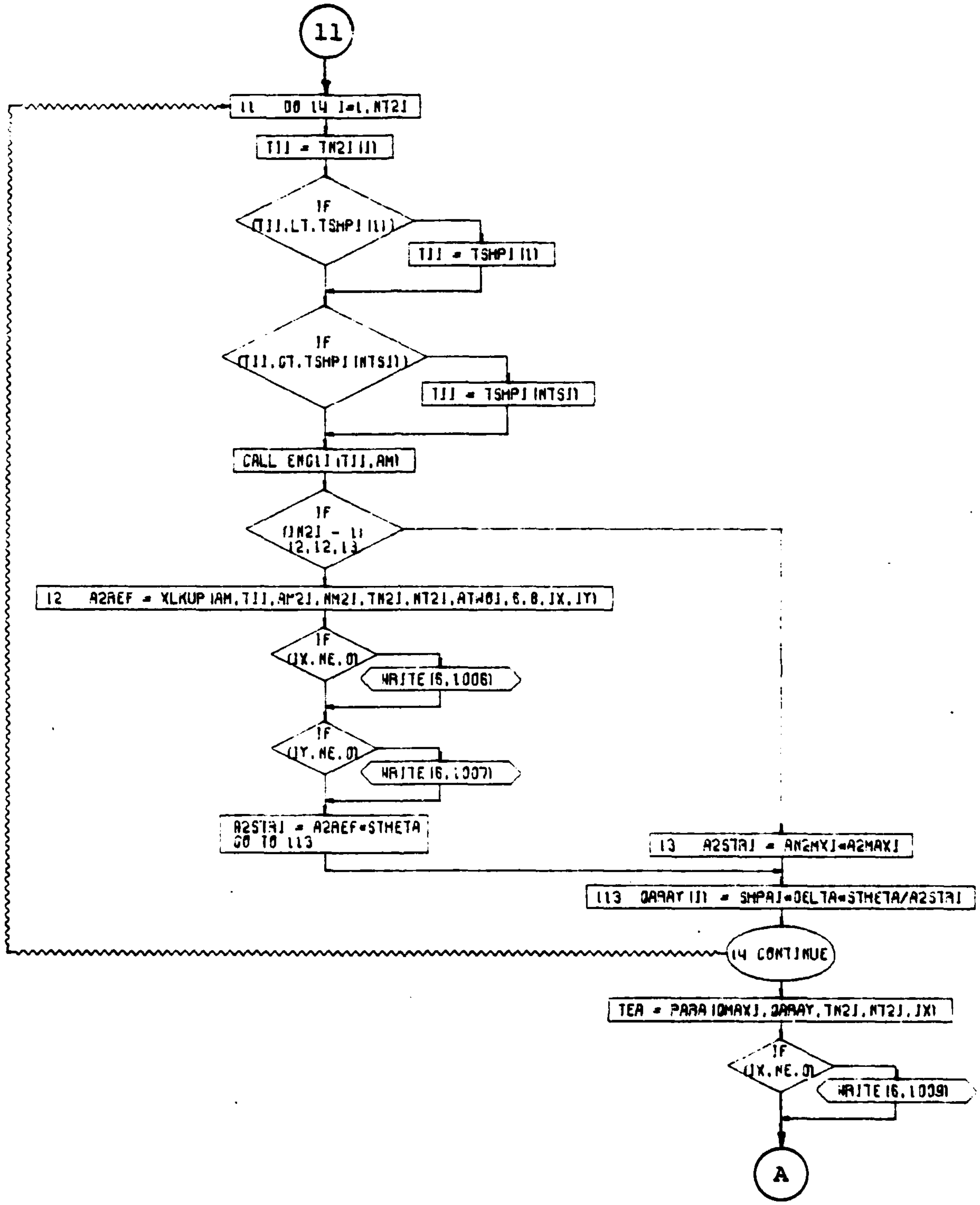


Figure 4-7. POWAVI Subroutine Flow Chart (Part 5 of 7).

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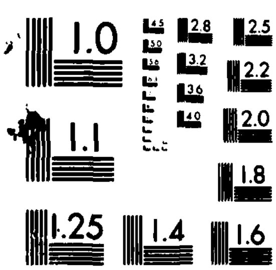


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

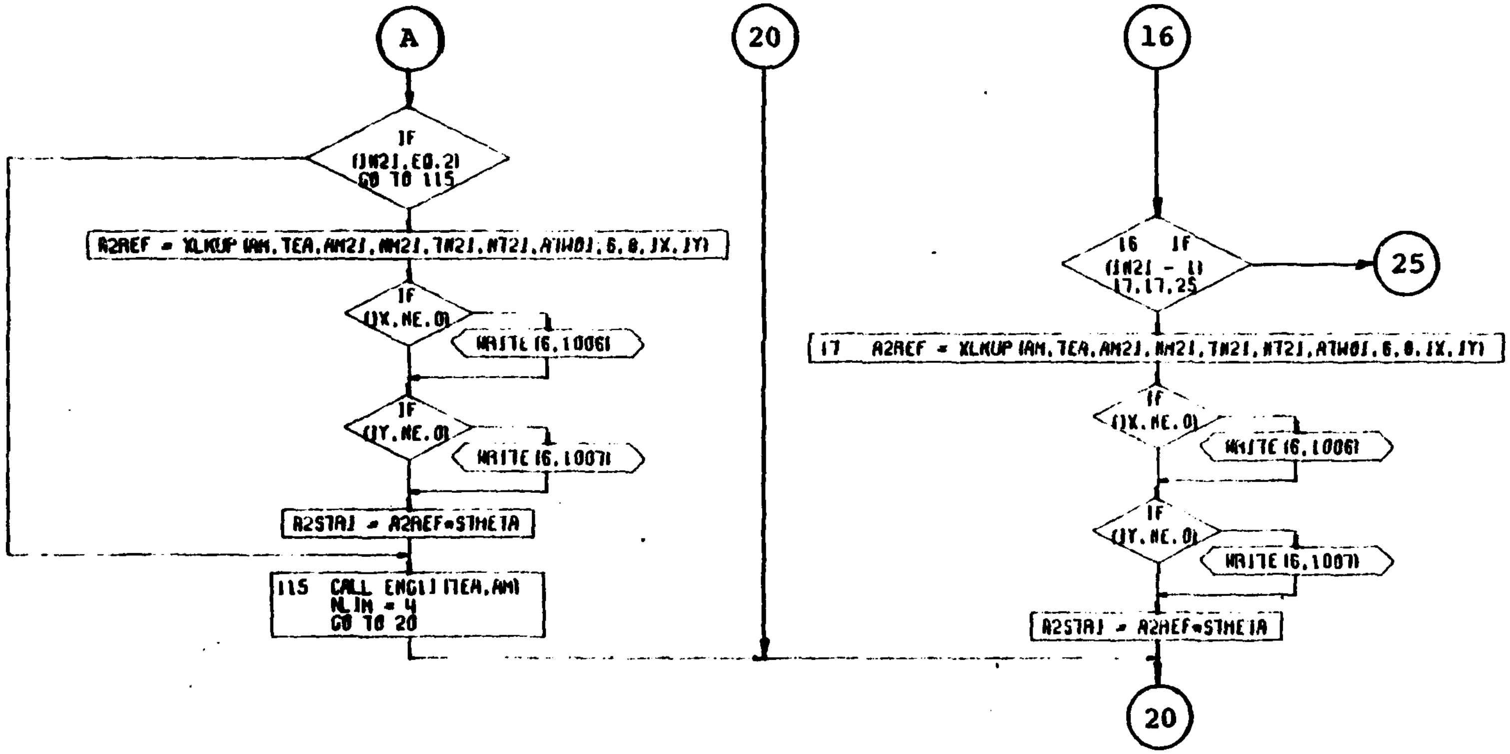


Figure 4-7. POWAVI Subroutine Flow Chart (Part 6 of 7).

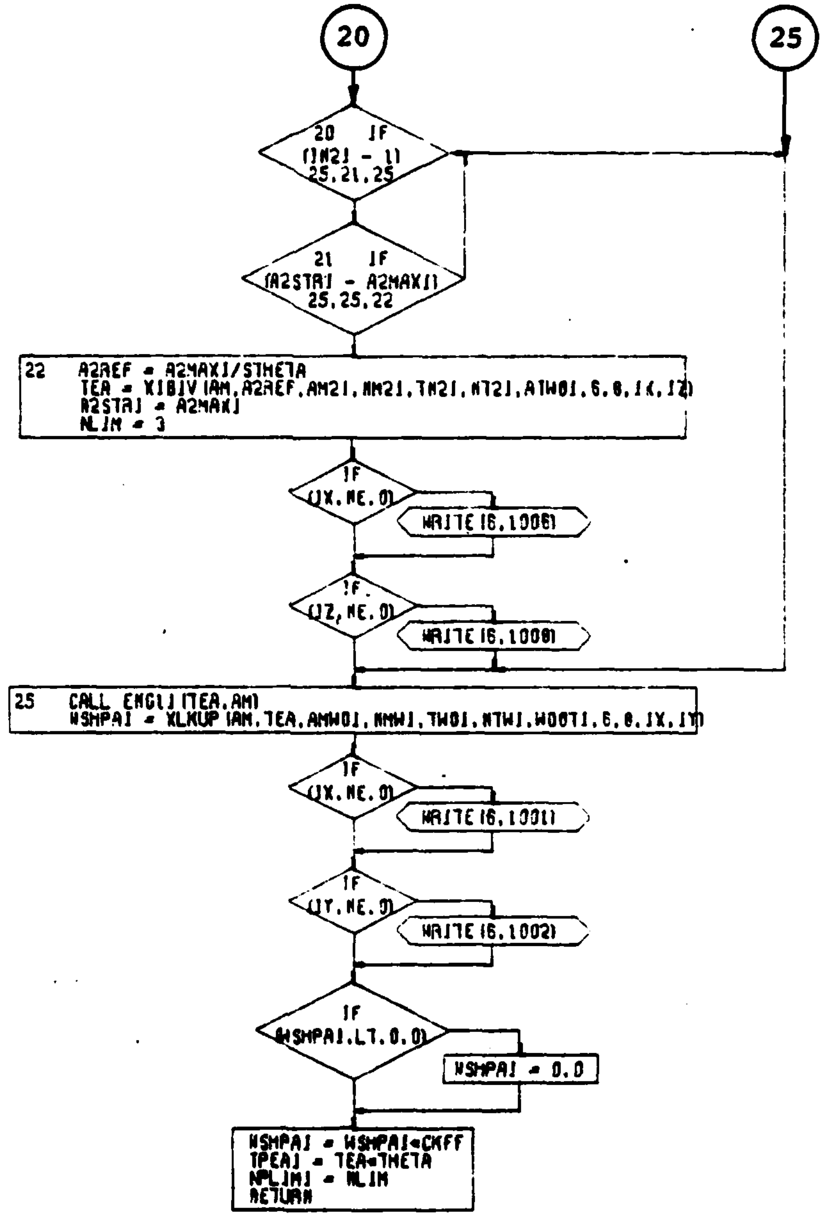


Figure 4-7. POWAVI Subroutine Flow Chart (Part 7 of 7).

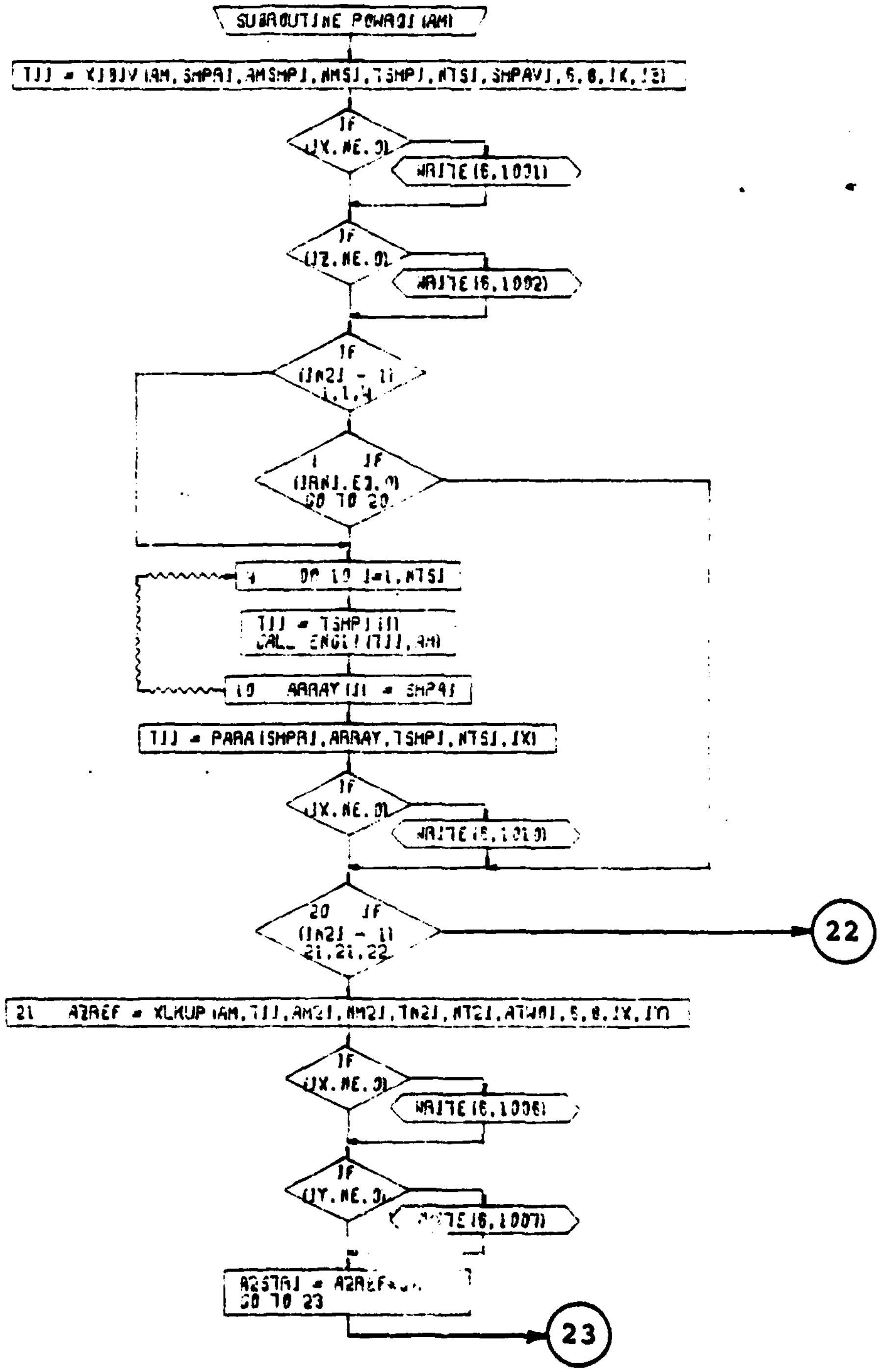


Figure 4-8. POWRQI Subroutine Flow Chart (Part 1 of 2).

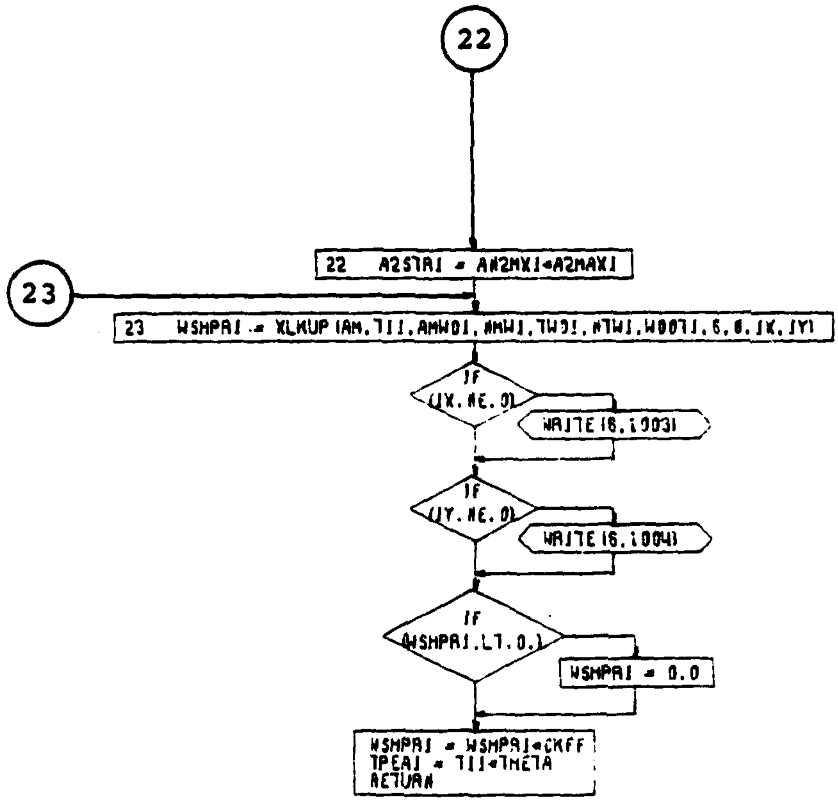


Figure 4-8. POWRQI Subroutine Flow Chart (Part 2 of 2).

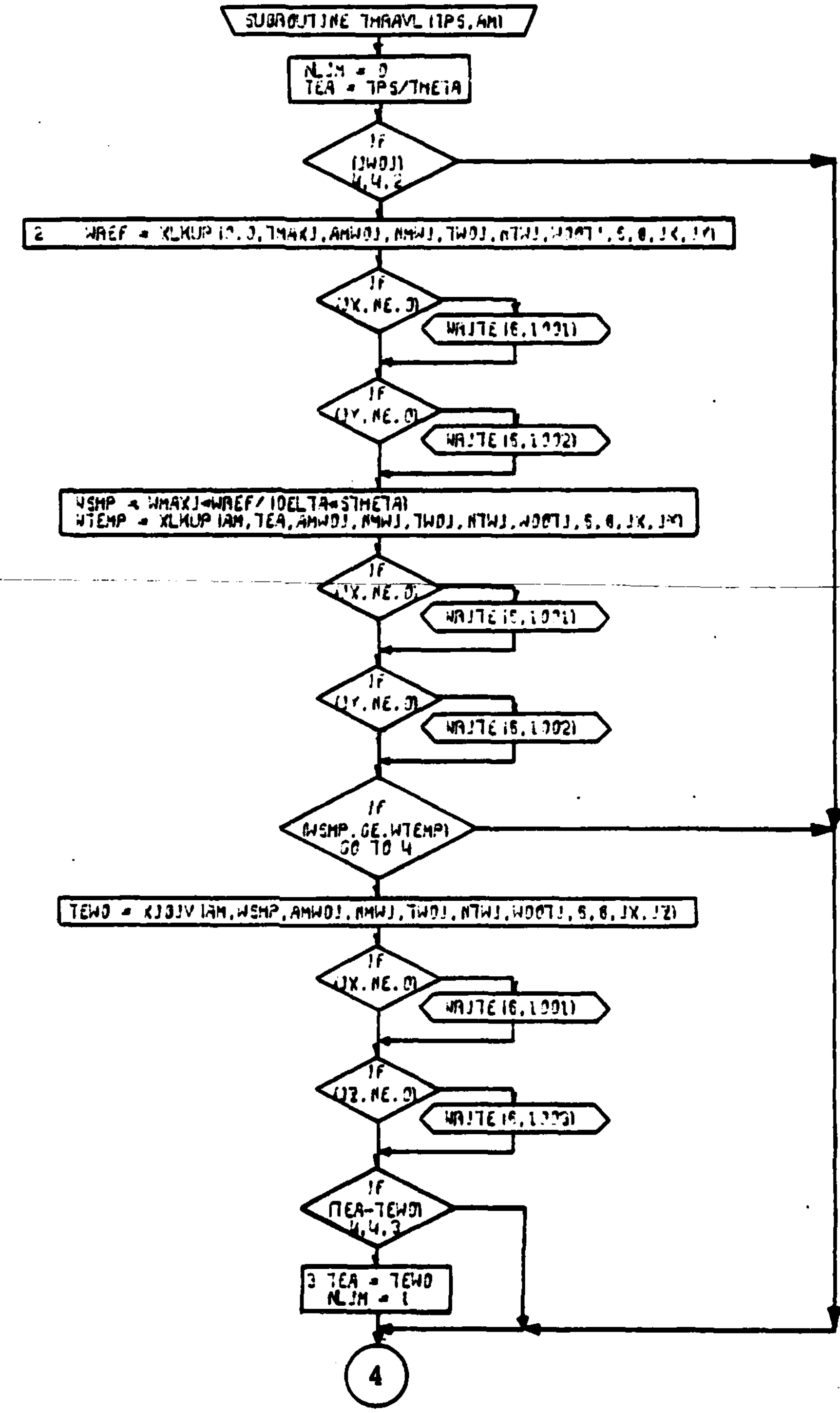


Figure 4-9. THRAVL Subroutine Flow Chart (Part 1 of 3).

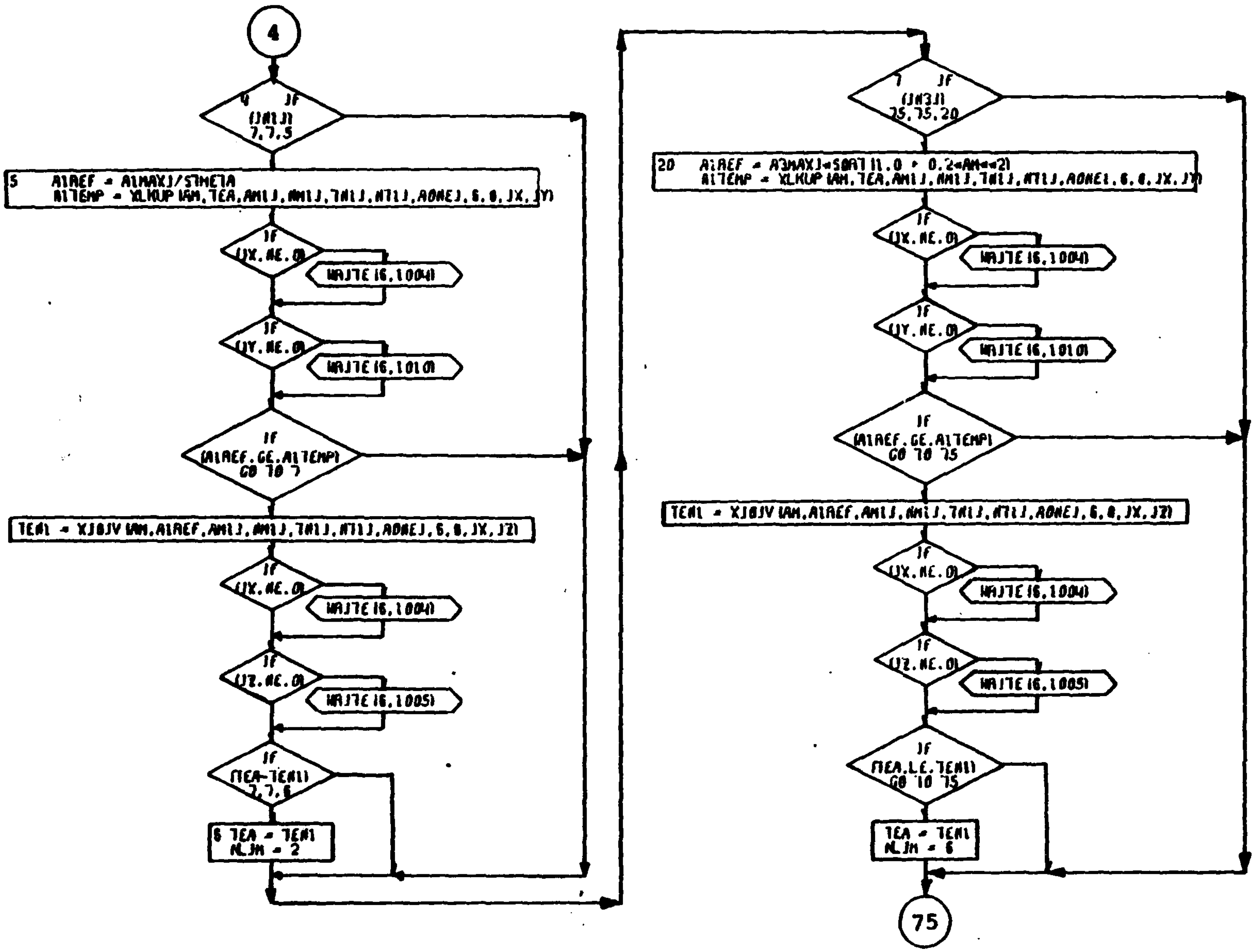


Figure 4-9. THRAVL Subroutine Flow Chart (Part 2 of 3).

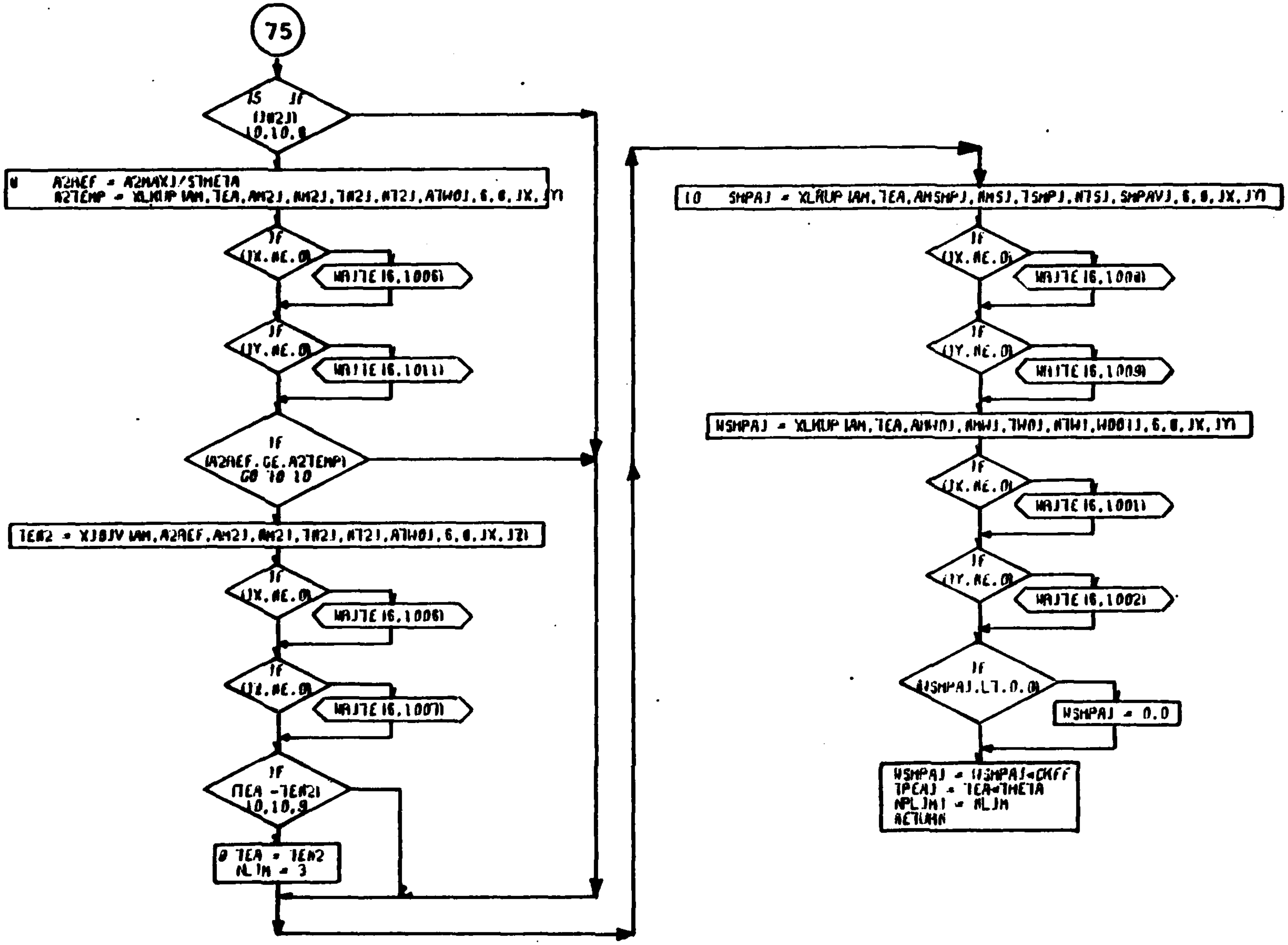


Figure 4-9. THRAVL Subroutine Flow Chart (Part 3 of 3).

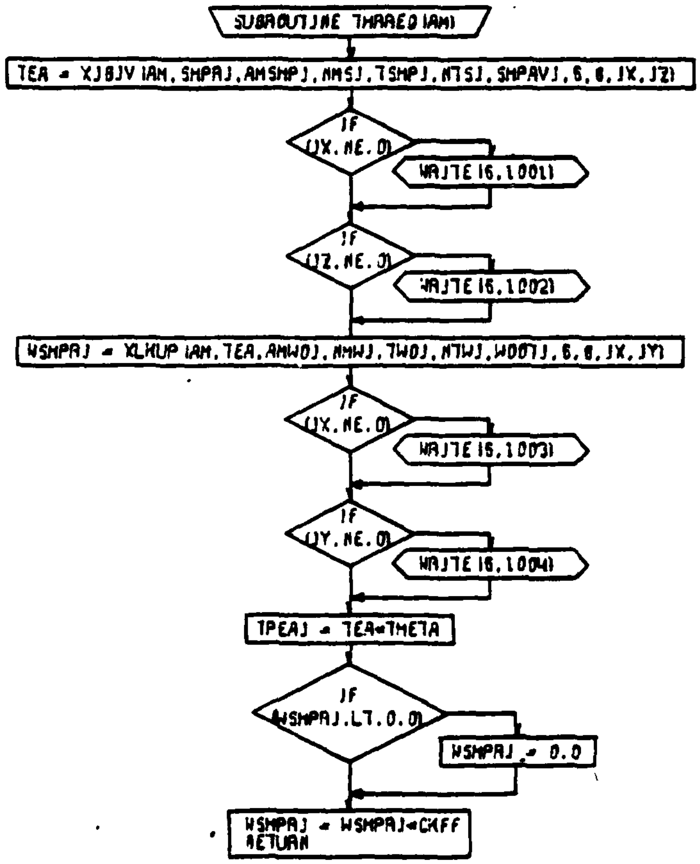


Figure 4-10. THRREQ Subroutine Flow Chart.

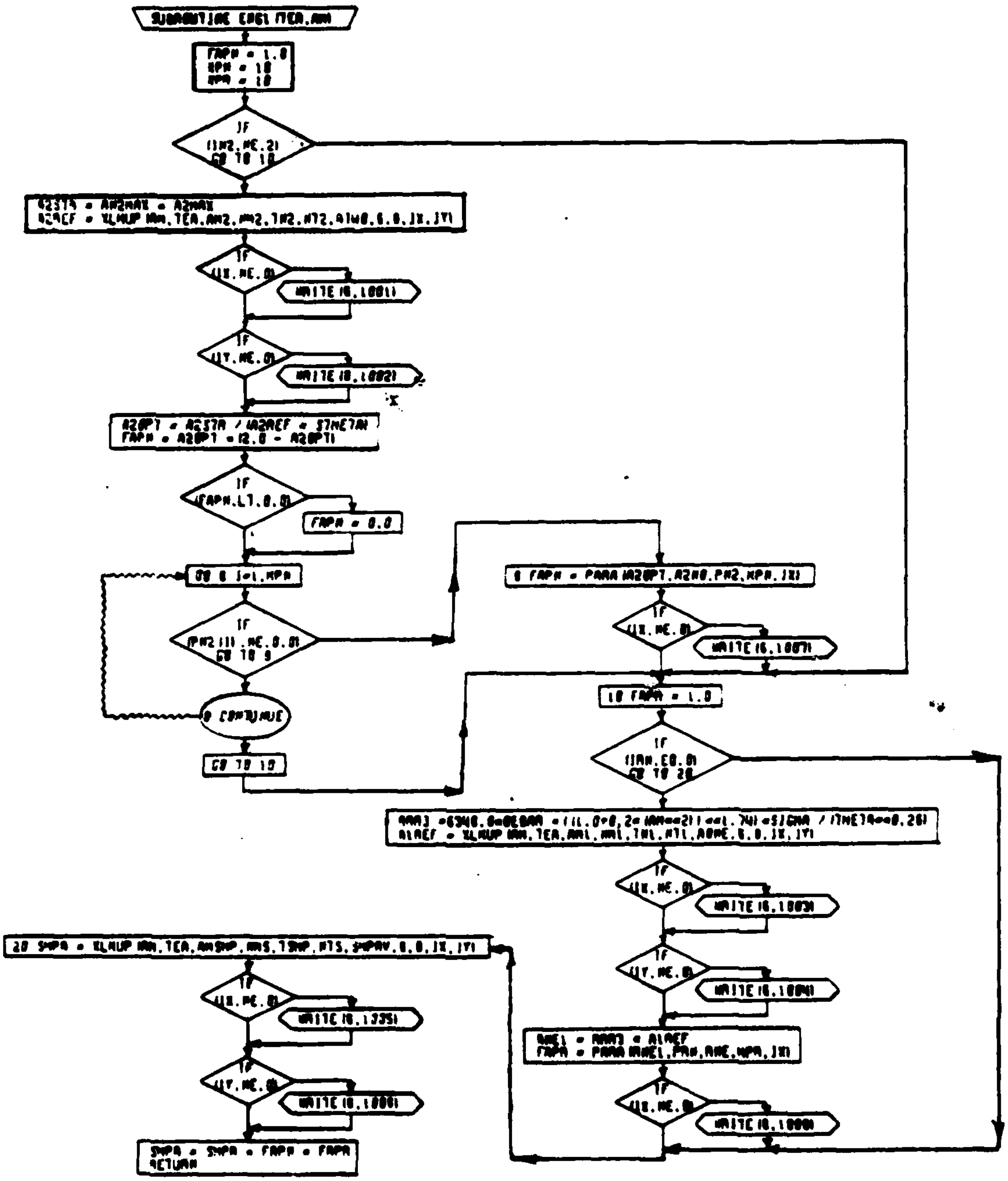


Figure 4-11. ENG 1 Subroutine, Flow Chart.

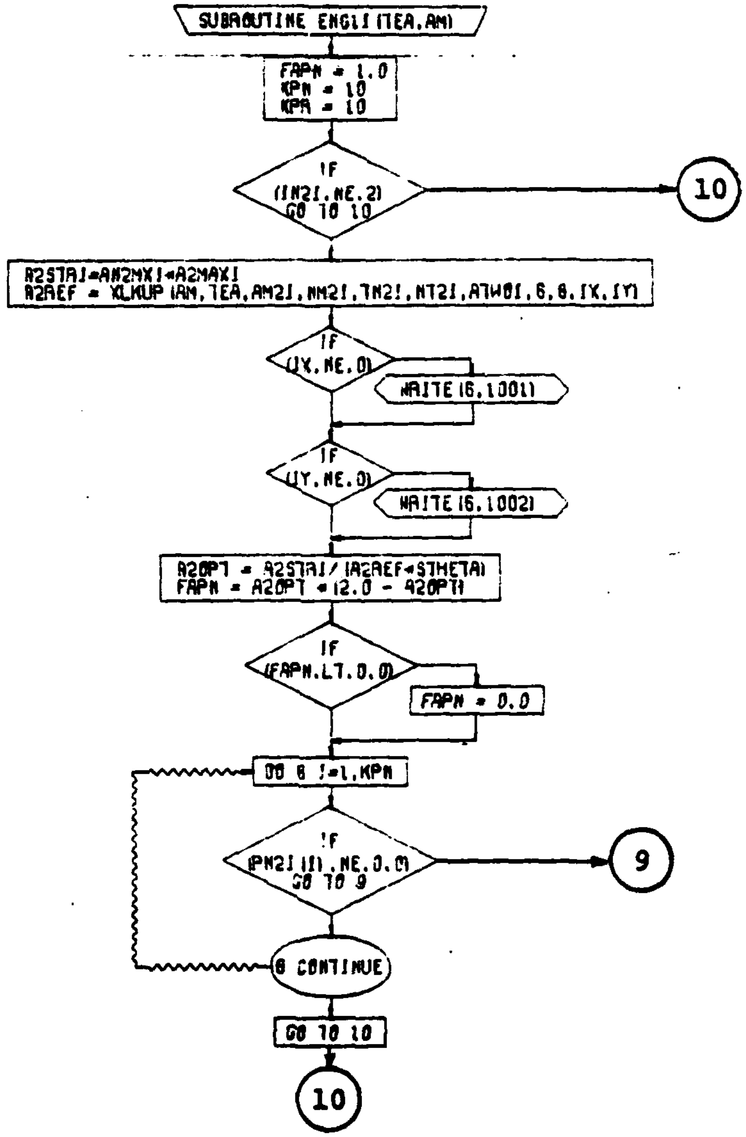


Figure 4-12. ENG 1 I Subroutine Flow Chart (Part 1 of 2).

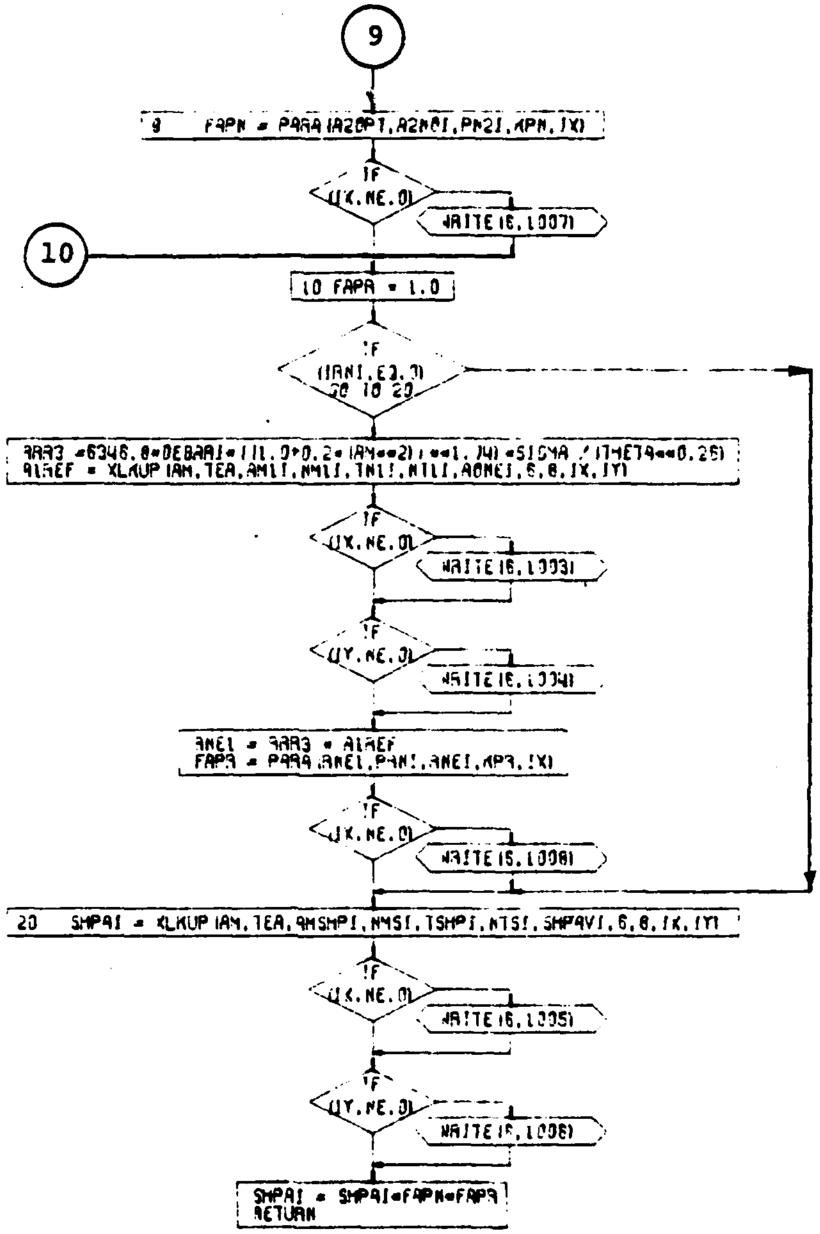


Figure 4-12. ENG 1 I Subroutine Flow Chart (Part 2 of 2).

4.5 ROTOR PERFORMANCE SUBROUTINE

Six options are available to the user for calculating rotor performance. These are specified by the indicator ROTIND as follows:

ROTIND

1 Rotor performance calculated by the "short form aero" rotor performance methodology

2 Rotor map is input, corrections are applied

3 Rotor map is input, no corrections are applied

4 Rotor map (L/D_E) is input. The program accepts V_{TIP} schedule and T_{AUX}/T schedule equal to 1000. Also, single point values of T_{AUX}/T are accepted. T_{AUX}/T schedule = 2000 cannot be used with this ROTIND = 4.

5. Rotor map (L/D_E) is input. The rotor is operated at maximum rotor L/D_E with T_{AUX}/T as output. The program accepts V_{TIP} schedule and T_{AUX}/T schedule. T_{AUX}/T = 2000 may be used with this option to define specified propulsive mode of operation up to a given value of M. Above this value of M, the rotor is operated at maximum L/D_E with T_{AUX}/T as output. ROTIND = 5 can be used only when AUXIND (Loc 0006) > 2. and $\eta_{P_{IND}}$ (Loc 0253) = 0.

6. Rotor map (L/D_E) is input. This option is similar to ROTIND = 5. except that the rotor is operated at maximum configuration L/D_E with T_{AUX}/T as output.

The first option (ROTIND = 1), using the short form aero methodology, allows the user to calculate rotor performance for a wide range of rotors with a minimum amount of input. The user is required to input a rotor cycle (a list of currently available cycles is illustrated in Table 2-4) and such blade characteristics as blade number, twist, and cutout. In the case of a single rotor helicopter, tail rotor blade characteristics must also be input. The short form aero methodology, developed at Boeing (References 2, 3, and 4), combines momentum theory and empirical corrections through coefficients found in the rotor cycles.

The four elements of the rotor power required are:

a) induced power (power required to generate lift)

b) profile power (power required to turn the rotor)

c) parasite power (power required to supply porpulsive thrust in forward flight).

d) nonuniform downwash power (power correction due to nonuniform inflow and downwash effects in forward flight).

The data used in this approach has been derived and correlated for rotors operating within the following parametric ranges:

Blade Number	=	2 - 8
Blade Twist	=	0 - -18°
Blade Root Cutout	=	0.20R
Rotor Solidity	=	0.055 - 0.150
Rotor Advance Ratio	=	0 - 0.4

No appreciable loss in accuracy is likely for cases involving more than eight blades, less than 20 percent root cutout or a solidity lower than 0.055. The level of confidence will be reduced, however, for those cases in which the rotor parameters greatly exceed the ranges shown above. Figure 4-13 illustrates a typical comparison of short form aero predicted performance and flight test data.

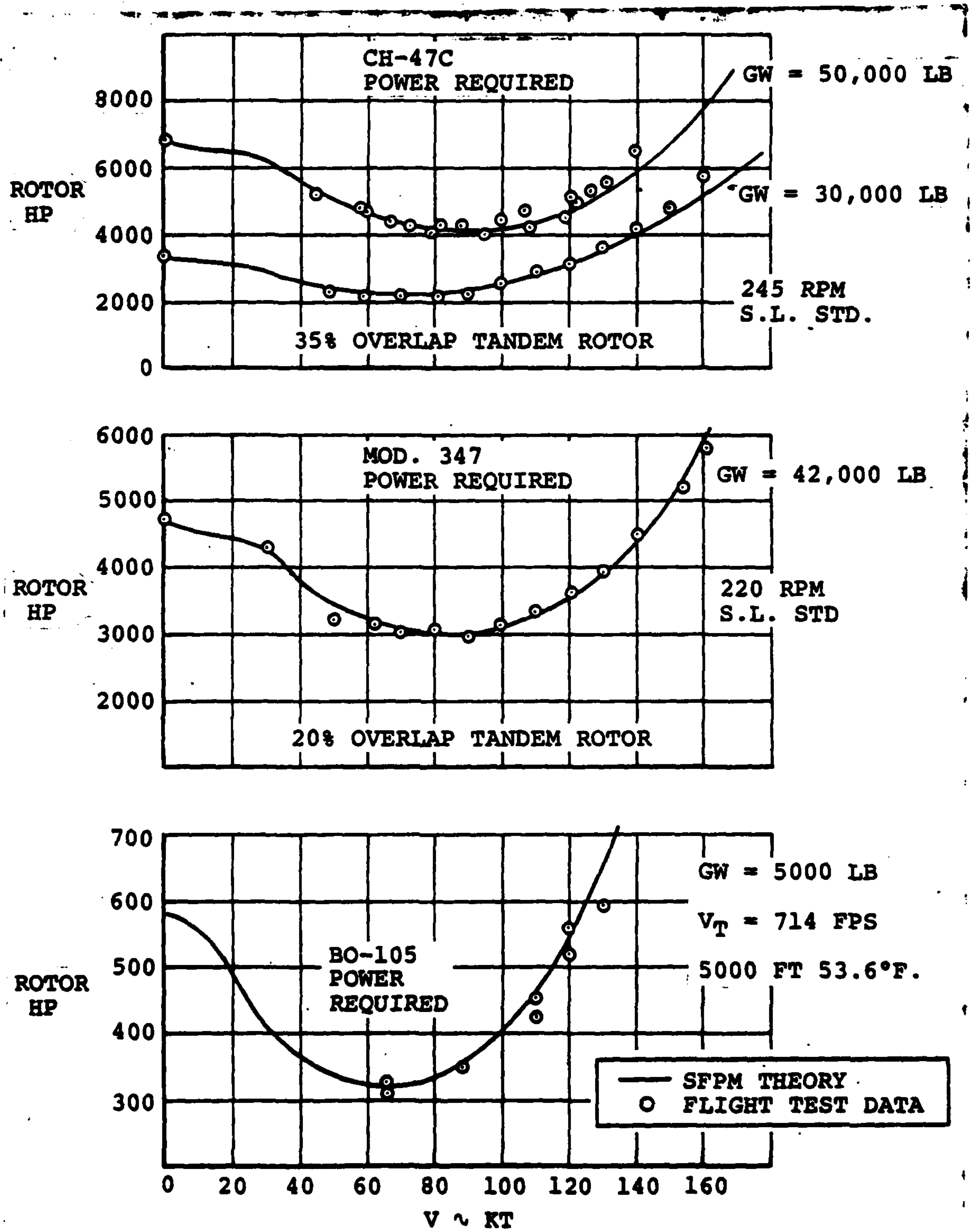


Figure 4-13. COMPARISON OF "SHORT FORM AERO" ROTOR PERFORMANCE AND FLIGHT TEST DATA

Figure 4-14 is a summary of the major equations used in this methodology. A brief description of their applications follows:

In hover, the rotor power required is composed of only two parts, induced and profile power. The induced power as represented by the equations in Figure 4-14 is a function of the variables K_{HOV}, K_{OL}, and C_T. K_{HOV} is the adjustment for nonuniform inflow and wake contraction effects and is a function of C_T, blade number, and blade twist. K_{OL} is the correction for overlapping rotors (as in the case of a tandem rotor helicopter.)

The profile power is simply a function of the integrated blade drag coefficient (including compressibility effects) at a specified operating C_T/σ and blade solidity.

In cruise, the rotor power is composed of all four of the components listed initially. The induced power, as represented by the equations in Figure 4-14, is a function of the quantities K_{IND}, K_{INT}, C_T', and μ'. K_{IND} is the induced power adjustment factor which accounts for blade tip and other losses. K_{INT} is the induced power adjustment for interference between tandem rotors. Thus, for single rotor helicopters, K_{INT} is equal to 1. For tandem rotors, the value of K_{INT} is calculated based on tandem rotor overlap and an empirically derived wake separation angle, ξ'. Profile power is simply a function of the integrated blade drag coefficient (corrected for retreating blade stall and advancing blade compressibility effects) at specified operating conditions (C_T'/σ, μ, C_X), blade solidity, and advance ratio (μ). The parasite power is a function of the propulsive thrust required and the efficiency of the rotor in converting power into that propulsive thrust (in addition to providing lift). The nonuniform downwash (NUD) power is a correction which has been empirically derived from a comparison of uniform and nonuniform downwash rotor analyses. The term K_{NUD}, which is a function of the advancing rotor, is stored as BLOCK DATA in this program, and is graphically represented in Figure 4-15.

MAIN ROTOR IN HOVER SUMMARY	MAIN ROTOR IN CRUISE FLIGHT SUMMARY
$RHP_{TOT} = \frac{\rho A V_T^3 C_{P_{TOT}}}{550}$	$RHP_{TOT} = \frac{\rho A V_T^3 C_P}{550}\ TOT$
where: $C_{P_{TOT}} = C_{P_{PRO}} + C_{P_{IND}}$	where: $C_{P_{TOT}} = C_{P_{PRO}} + C_{P_{IND}} + C_{P_{PAR}} + C_{P_{NUD}}$
(PROFILE POWER) $C_{P_{PRO}} = C_{D_O} \frac{\sigma}{8} (1 - X_C)$	(PROFILE POWER) $C_{P_{PRO}} = \frac{C_{D_O}\sigma}{8} (1 + 4.65\mu^2)(1 - X_C)$
(INDUCED POWER) $C_{P_{IND}} = .707 K_{HOV} K_{OL} C_T^{3/2}$	(INDUCED POWER) $C_{P_{IND}} = \frac{K_{IND} K_{INT}}{2\mu'} C_T'^2$
$C_T = \frac{\text{HOVER THRUST REQ'D}}{\rho A V_T^2}$	(PARASITE POWER) $C_{P_{PAR}} = \mu C_X\ (K_{PER})$
$A = \frac{\pi D^2}{4} N_{ROT}$	(NUD POWER) $C_{P_{NUD}} = \frac{2K_{NUD} C_T' \sigma}{B^2\ (1 + D.L.\ \sin^2\epsilon)}$
$X_C = 2r_{cutout}/D$	$C_T' = \frac{L_{ROT}}{\rho A V_T^2} (1 + D.l.\ \sin^2\epsilon)$
	$C_X = \frac{X_{TOT}}{\rho A V_T^2}$ $A = \frac{\pi D^2}{4} N_{ROT}$
	$\epsilon = \tan^{-1} (2V / V \times 1.689)$
	$K_{PER} = \frac{\mu_{PRI}}{\mu_{PRR}} = 1 + 12.8\mu^4$
	$v_i = V_T \sqrt{[(\mu^4 + C_T^2)^{1/2} - \mu^2]/2}$
	$\mu' = \frac{\sqrt{(1.689V)^2 + v_i^2}}{V_T}$ $K_{NUD} = f(\mu)$

Figure 4-14. Short Form Aero Rotor Performance Equations Summary.

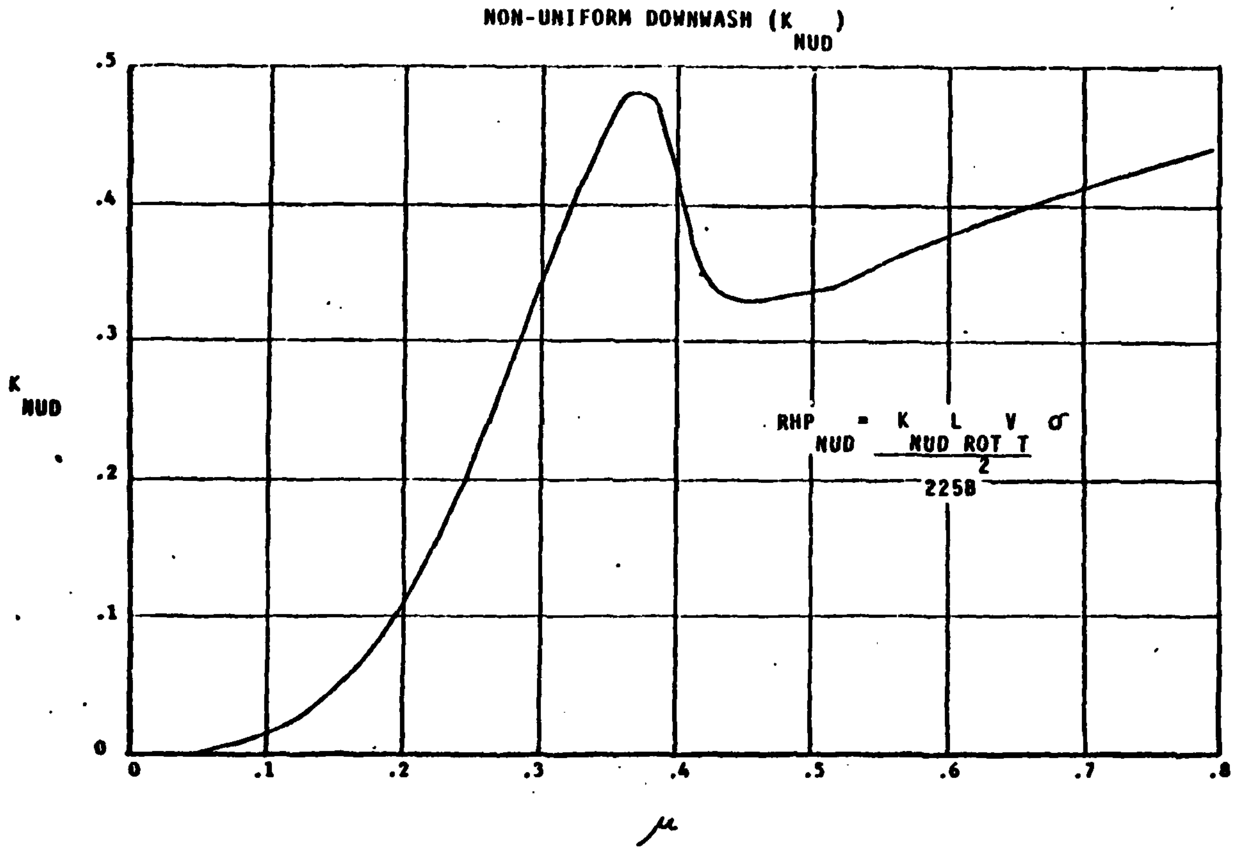


Figure 4-15. Non-Uniform Downwash as Stored in Block Data

In order to obtain a reasonable estimation of power required at very low advance ratios ($\mu < 0.1$) where neither normal cruise nor hover rotor characteristics totally describe the operating environment of the rotor, an empirical fairing technique is used. The method is based on the contracted induced wake angle ξ :

$$\xi = \tan^{-1}((2V_i \ 1(1.689V))$$

The relationship:

$$\sin^2\xi + \cos^2\xi = 1$$

is used to provide a smooth transition between hover and cruise characteristics for the affected coefficients while insuring that the resulting values will lie within the boundaries set by hover and cruise limiting conditions.

A detailed description of the equations used in this methodology is provided by inspection of Figure 4-19 (subroutine ROTPOW flow chart) and the input variable list included in paragraph 5.3.1 of Section 5.0. The empirical factors used in this methodology are input as noted earlier, in "rotor cycle" format. The input sheet used for this purpose is included in the specimen input sheets of Section 5.2. It should be noted that since the factors specified in a "rotor cycle" represent integrated blade characteristics, then a given "rotor cycle" implicity represents a given spanwise chord and airfoil distribution. Thus, it would ultimately be possible to build up an extensive library of "rotor cycles" with varying combinations of planform and airfoil distributions.

The second option (ROTIND = 2) utilizes isolated rotor data (Type I rotor map) derived for a specified rotor configuration, but corrected by the program for the specific rotor and helicopter configuration being analyzed. It should be noted that this option, in the case of the single rotor helicopter, utilizes the short form aero methodology for calculating tail rotor power. Thus, the same tail rotor blade information required in the first option must be input.

Option three (ROTIND = 3, Type I rotor map) uses total configuration rotor data; that is, in the case of a single rotor helicopter, this would include both main and tail rotor power and applies no corrections to the data. Input locations 2700-3410 are provided for the input of Type I rotor maps. Values of C_P/σ input as functions of up to ten values of C_T/σ at up to six values of M_{TIP} can be used for hover performance; and cruise C_P/σ values can be input as functions of up to ten values of C_T/σ and ten values of C_X/σ at up to six values of μ .

Options four (ROTIND = 4), five (ROTIND = 5), and six (ROTIND = 6) utilize the Type II rotor map data in the same manner as the secon option (ROTIND = 2). Input locations 3420-4130 are provided for the input of Type II rotor maps. Values of F.M. input as functions of up to ten values of C_T/σ at up to six values of M_{TIP} can be used for hover performance; and cruise L/D_E values can be input as functions of up to ten values of C_T/σ and six values of X/L at up to six values of .

A detailed description of the equations and variables used for ROTIND = 1,2,3,4,5, and 6 is available by inspection of Figure 4-16 and section 5.3.1, Program Variables. Figures 4-16 and 4-17 show the corrections (K_{DLD}, TIGE/TOGE) for hover inground effect applied to the equations:

$$T/W = 1 + DL(K_{DLD})$$

$$C_T = \frac{4W(T/W)}{\rho \pi D_{MR}^2 \, N_R \, V_{TIP}^2 \, (TIGE/TOGE)}$$

used in calculating hover power.

Care must be exercised in the preparation of input data for both Type I and II rotor maps. The performance subroutines employ search procedures which require input data to be specified considerably above and below the final operating point of a configuration. Therefore, "map" data should be provided over a wide range on either side of expected operating points.

For the calculation of vertical climb power, the subroutine uses the simple potential energy relationship:

$$RHP_{VRC} = \frac{W(V_{RC})}{33,000(V_{CEH1} + V_{CEH2}(V_{RC}))}$$

The vertical climb efficiency factors (V_{CEH_1} and V_{CEH_2}) can be derived from flight test data.

The quantity ALPHA D/L printed out in all forward flight performance segments reflects the propulsive thrust-lift vector of the main rotor. The following simple sketch illustrates the sign convention employed.

$$DLD_{CORR.FACT} = 1.028 - 1.25e^{-(2h_{B_F}/DIA.)}$$ SINGLE ROTOR

$$DLD_{CORR.FACT} = 1.36771 - 1.57913e^{-h_{B_F}/DIA.}$$ TANDEM ROTOR

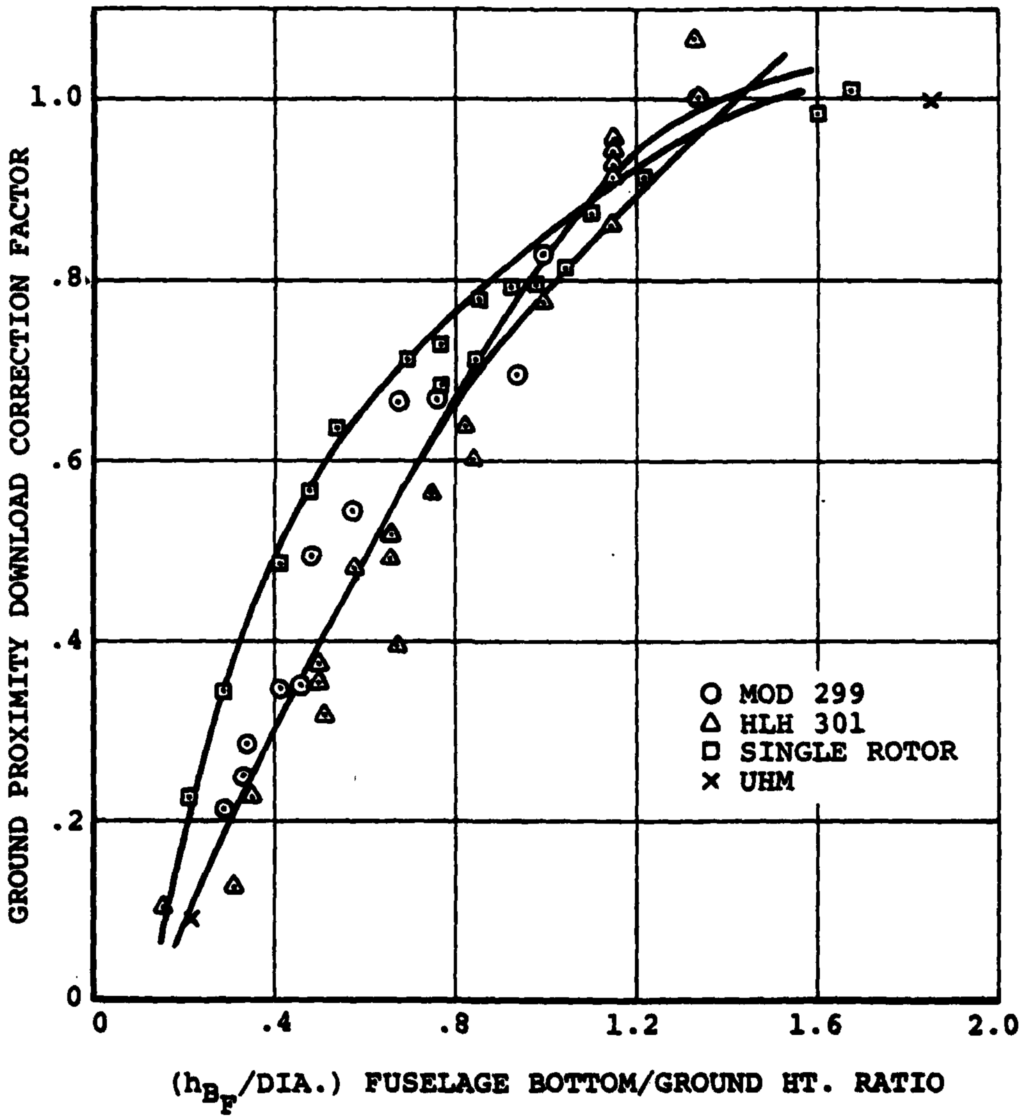


Figure 4-16. Download Sensitivity to Ground Proximity.

$$THRUST_{IGE}/THRUST_{OGE} = .06907(1/X) + .03364(X) + .90186$$

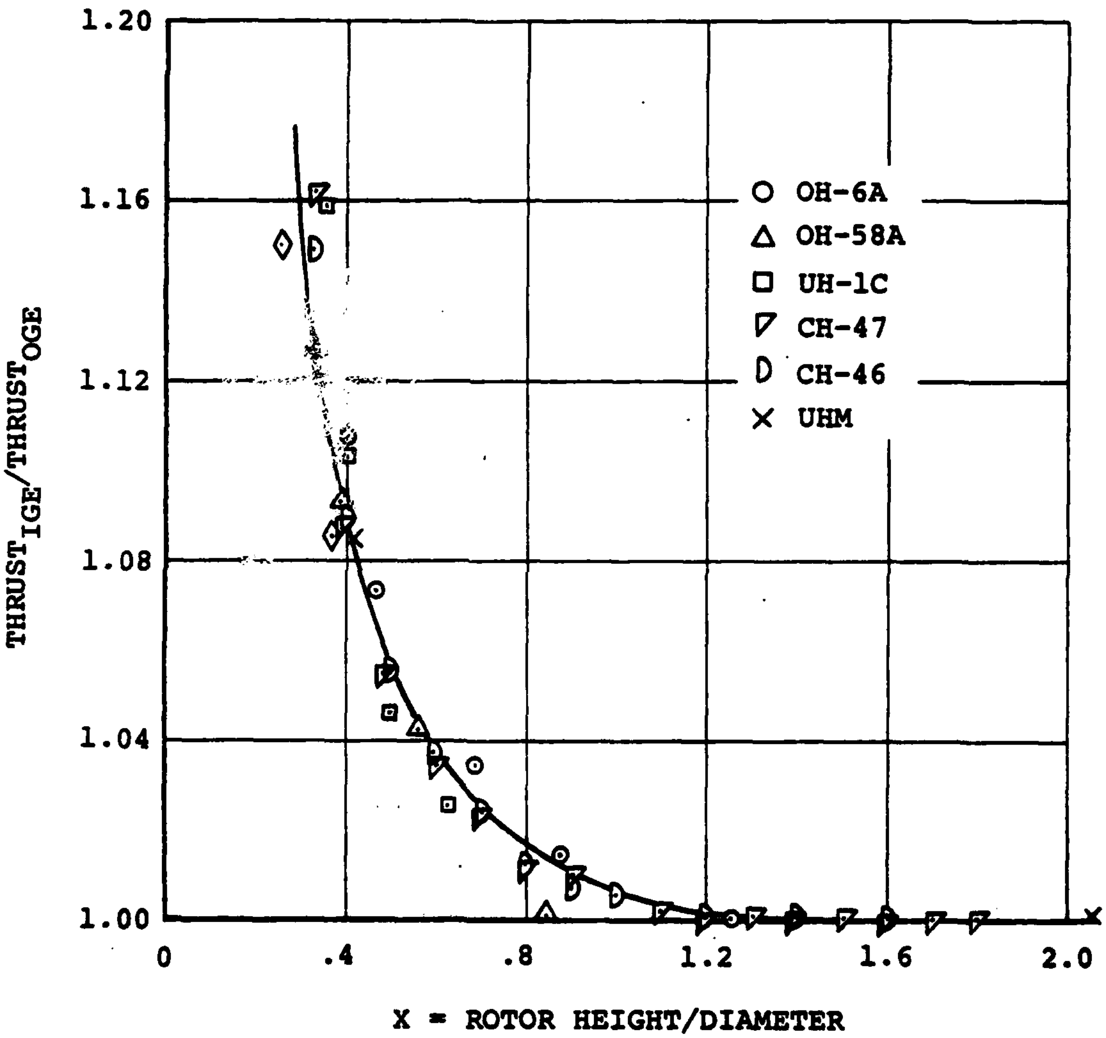
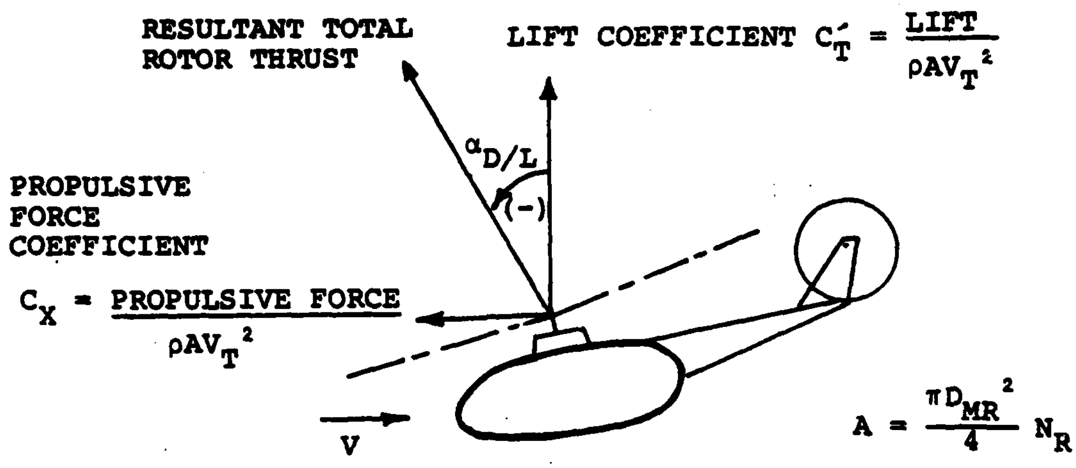


Figure 4-17. Thrust Augmentation in Ground Effect.



Rotor performance is calculated by HESCOMP utilizing the rotor maps of L/D_E vs μ, C_T'/σ and X/L. Using these maps, three types of rotor operations can be specified. These are:

(1) Flight at a fixed rotor propulsive force (T_{AUX}/T) level.

(2) Flight at maximum rotor L/D_E. In this case, rotor propulsive force (drag) is an output.

(3) Flight at maximum configuration L/D_E. In this case, rotor propulsive force (drag) is an output.

The configuration L/D_E is calculated from:

$$(L/D_E)_{CONFIG} = \frac{GW \times V_{KTAS}}{325.8 \times BHP}$$

Operation in either modes (2) or (3) includes a search for the X/L at which either maximum rotor or configuration L/D_E occurs. To accomplish this, HESCOMP interpolates the input rotor map data at the particular operating point (μ and C_T'/σ) and generates a data array of rotor L/D_E vs X/L. Figure 4-18 illustrates a typical plot of such data. In the case of operations in mode (3), an additional array of configuration L/D_E vs X/L is generated.

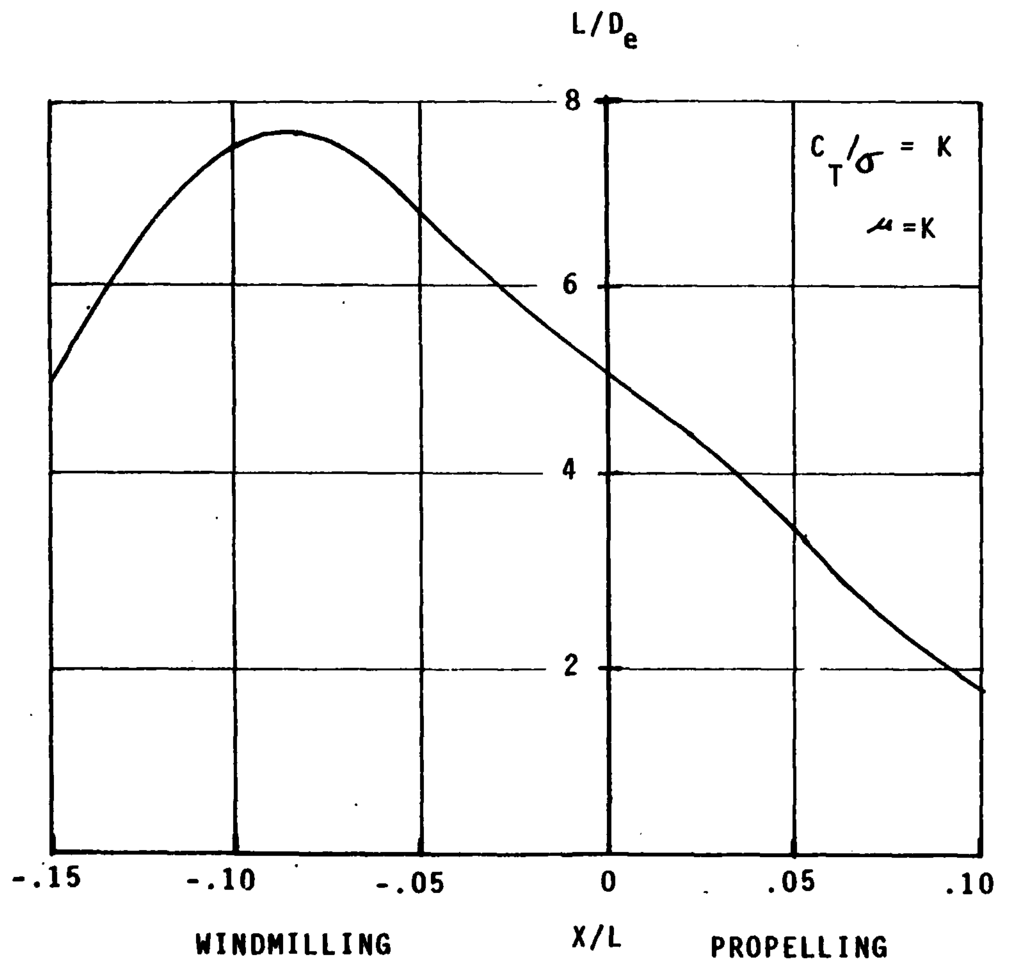


Figure 4-18. HESCOMP Interpolation of Rotor L/D_E vs. X/L

The search begins at the lowest value of X/L input and continues until the maximum value of L/D_E is obtained. For the maps used in HESCOMP, the range of X/L extends from -0.15 to +0.10. It is in this search procedure that the rotor maxim m lift limits described earlier are employed. As noted previously, these maximum rotor lift limits are input as function of μ and C_X/σ For a given operating point (μ and C_T'/σ), the limiting value of X/L can be defined as:

$$X/L = \frac{(C_X/\sigma)\ RL}{(C_T'/\sigma)\ RL}$$

Thus, if the limiting value of X/L is exceeded in such a search, rotor X/L is reduced until the operating point and the rotor lift limit are matched.

The flow chart for the rotor power subroutine is illustrated by Figure 4-19.

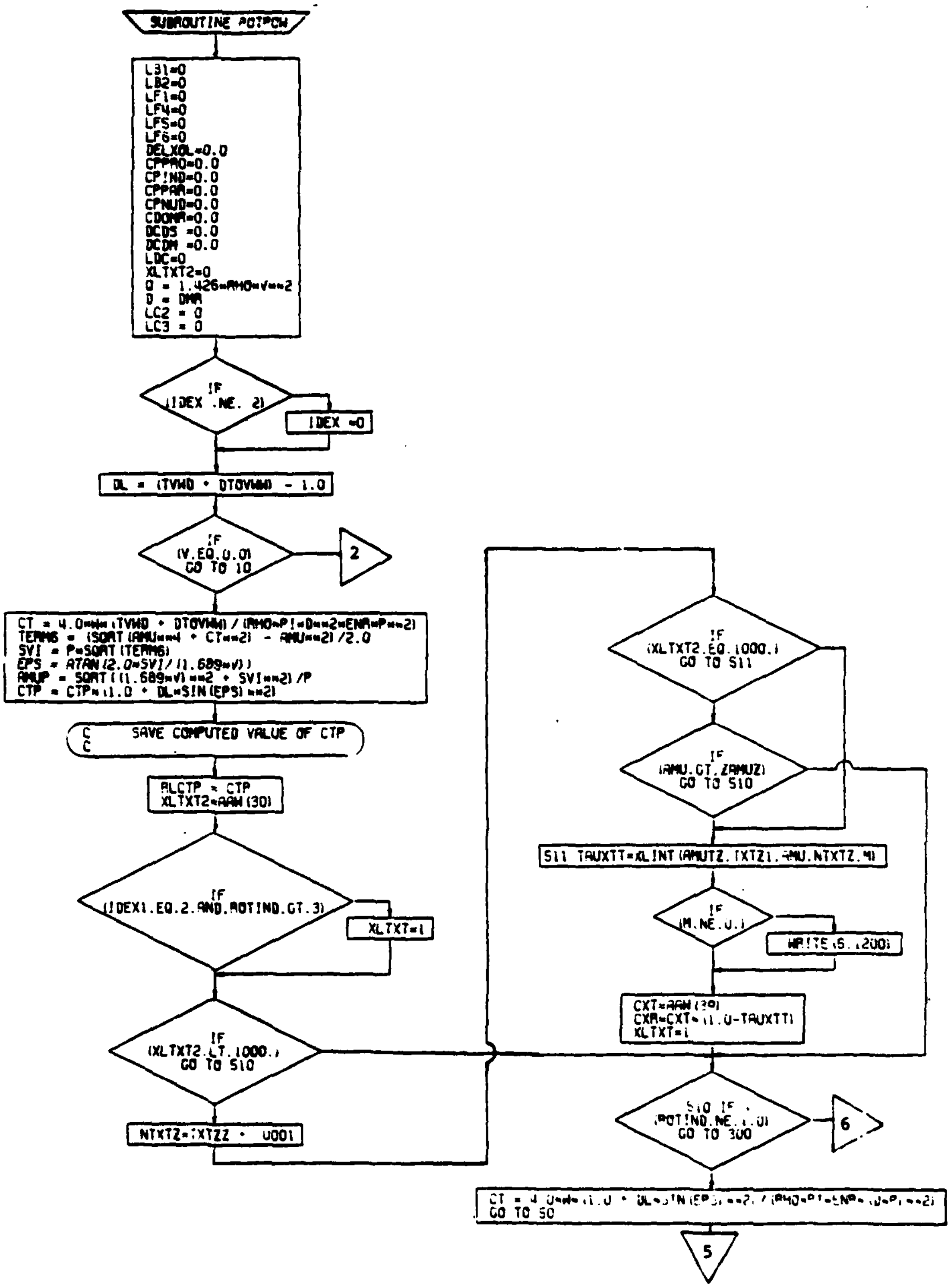


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 1 of 23)

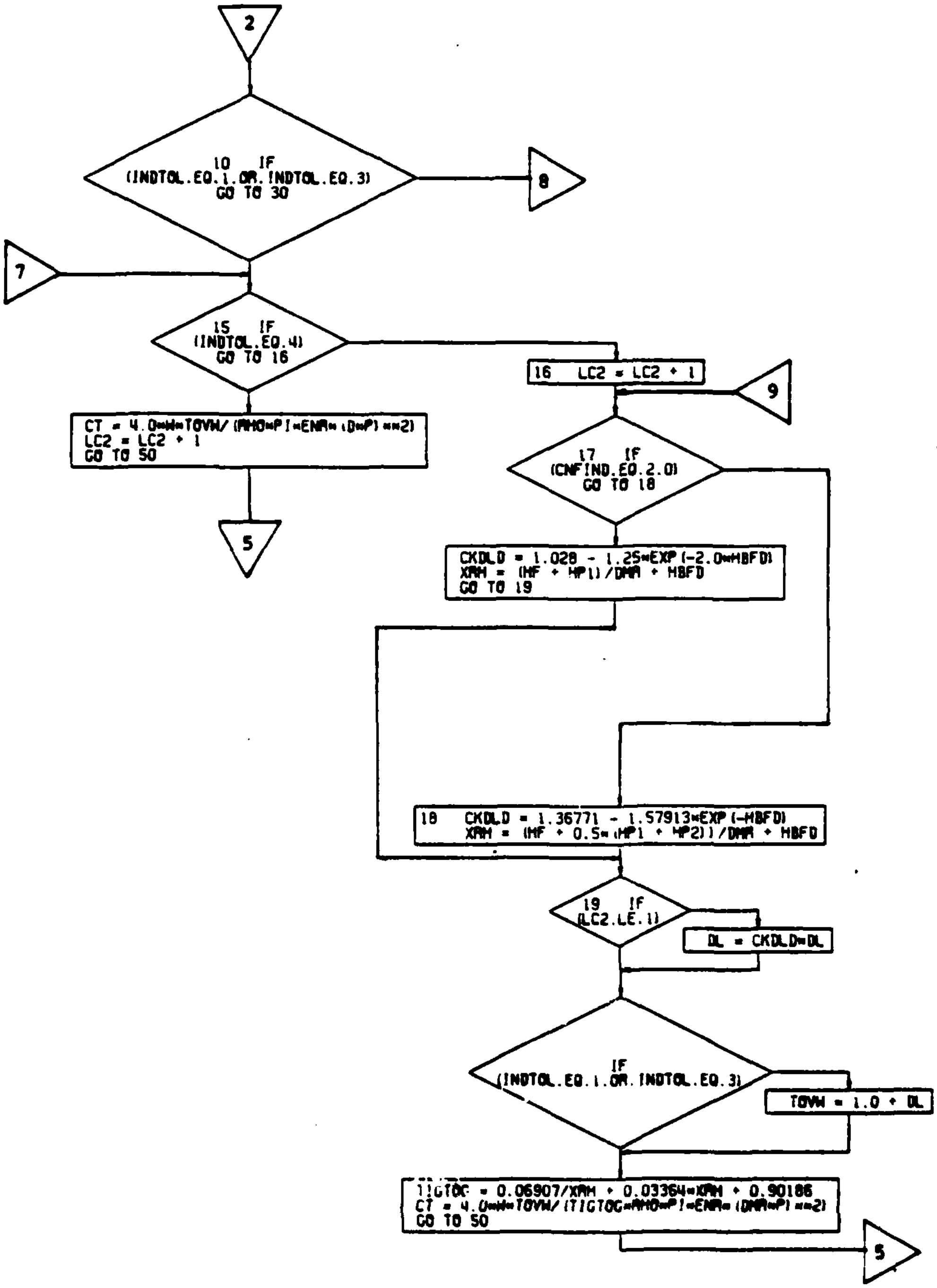


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 2 of 23)

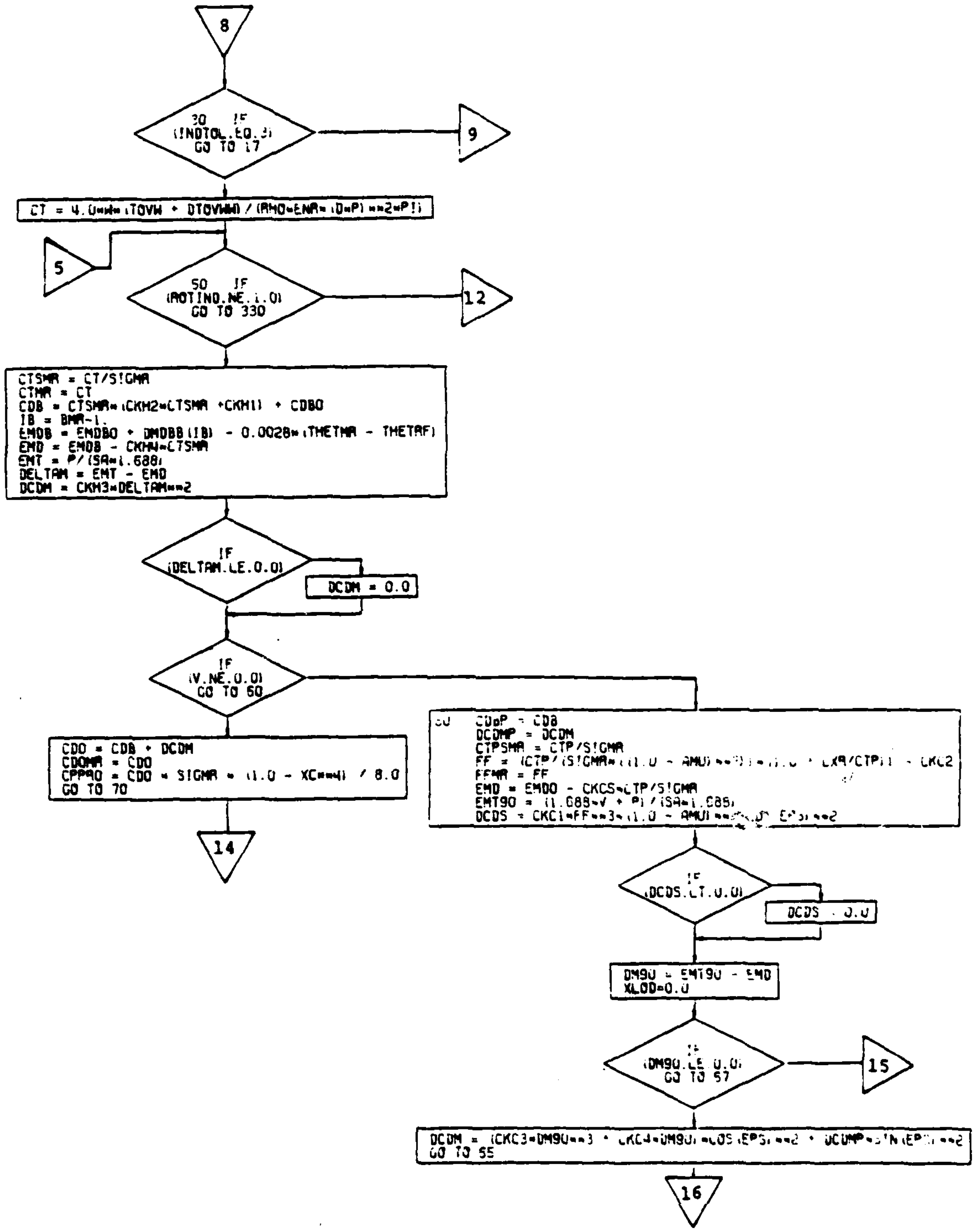


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 3 of 23)

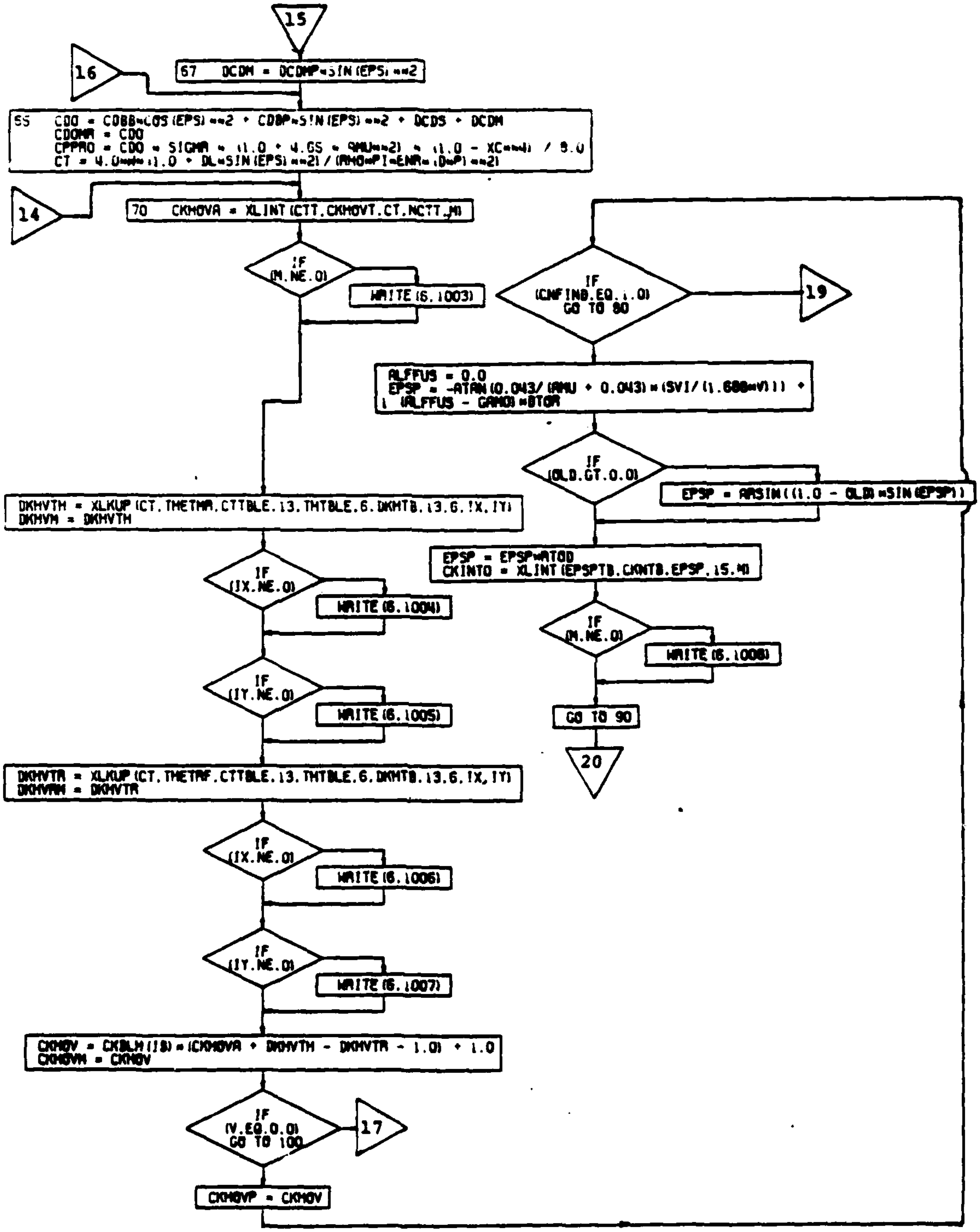


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 4 of 23)

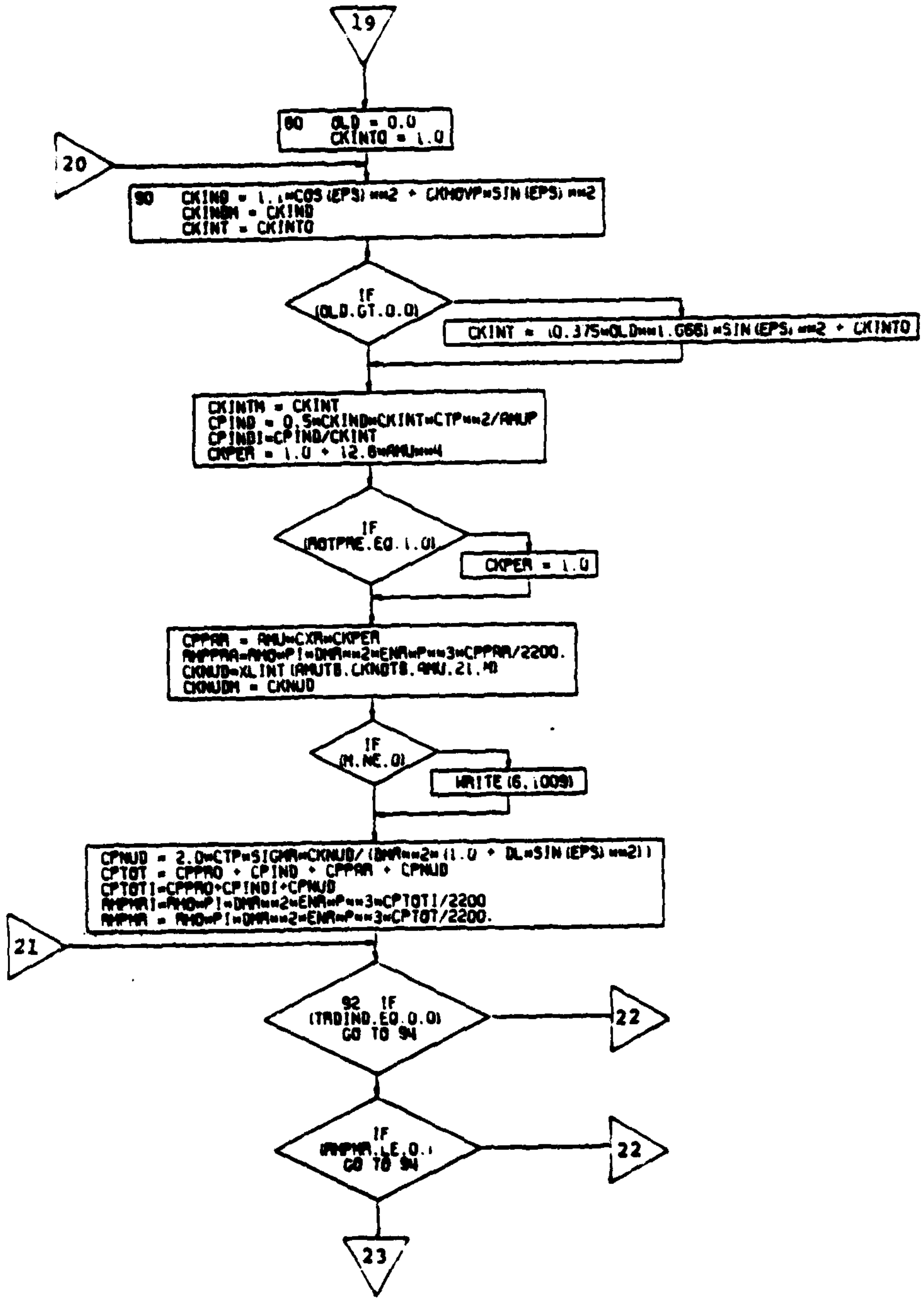


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 5 of 23)

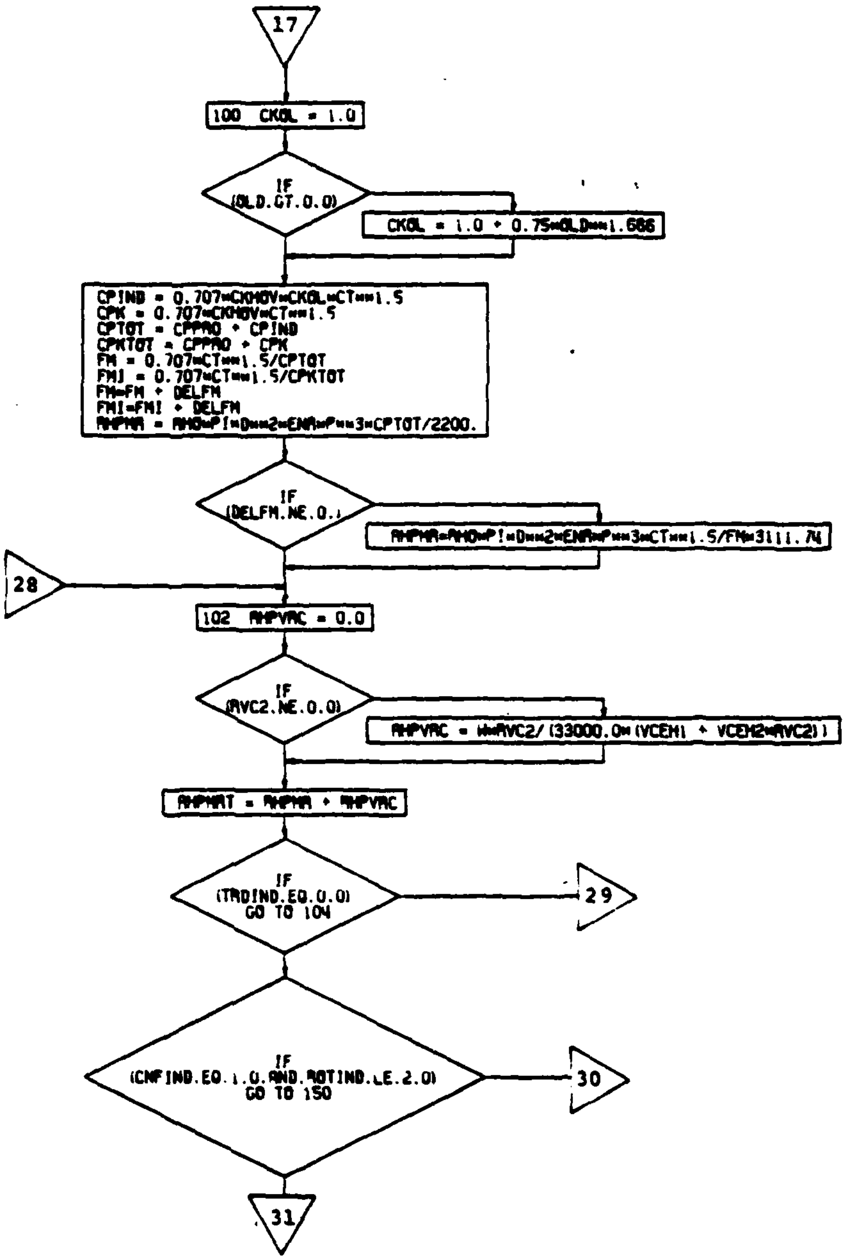


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 6 of 23)

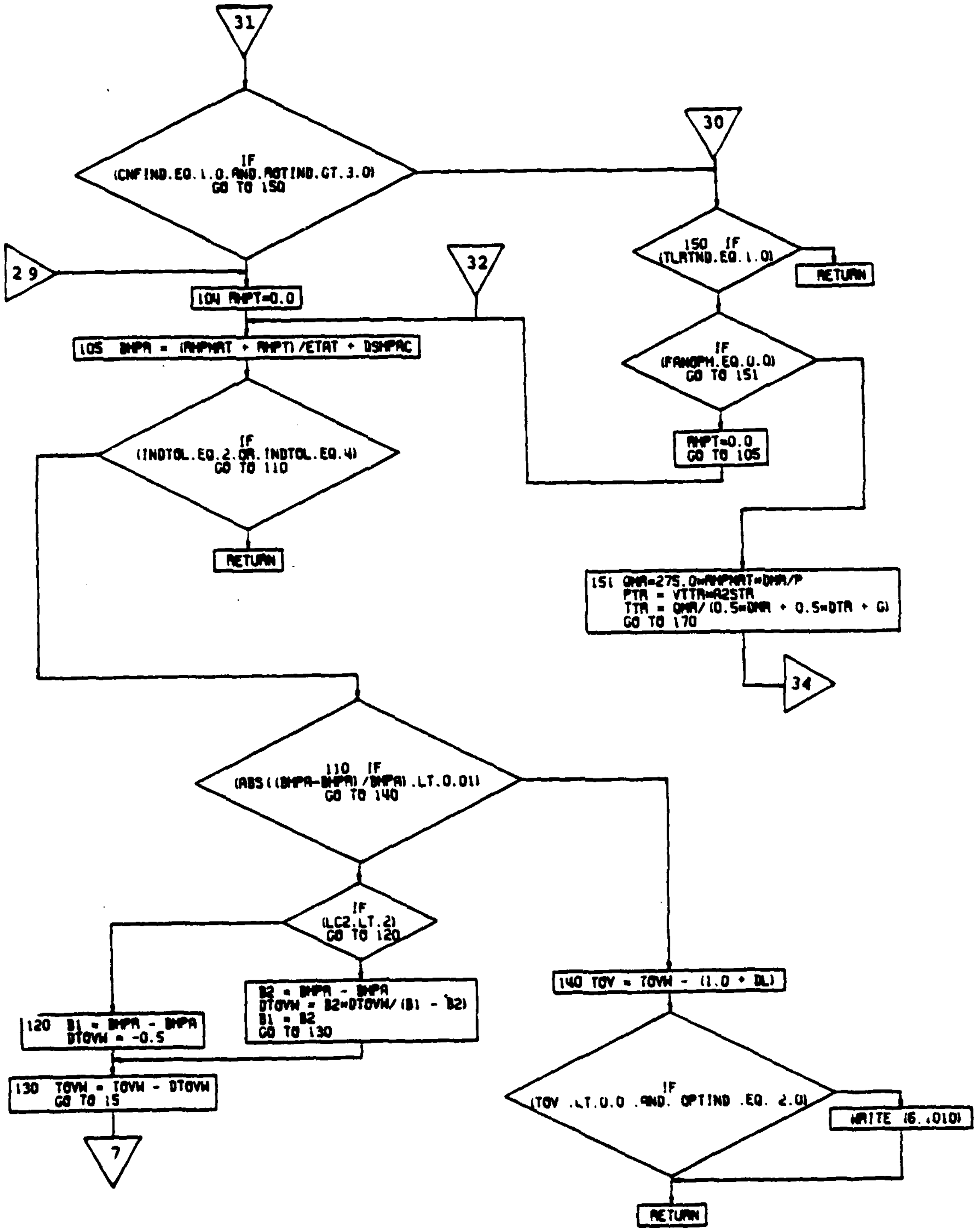


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 7 of 23)

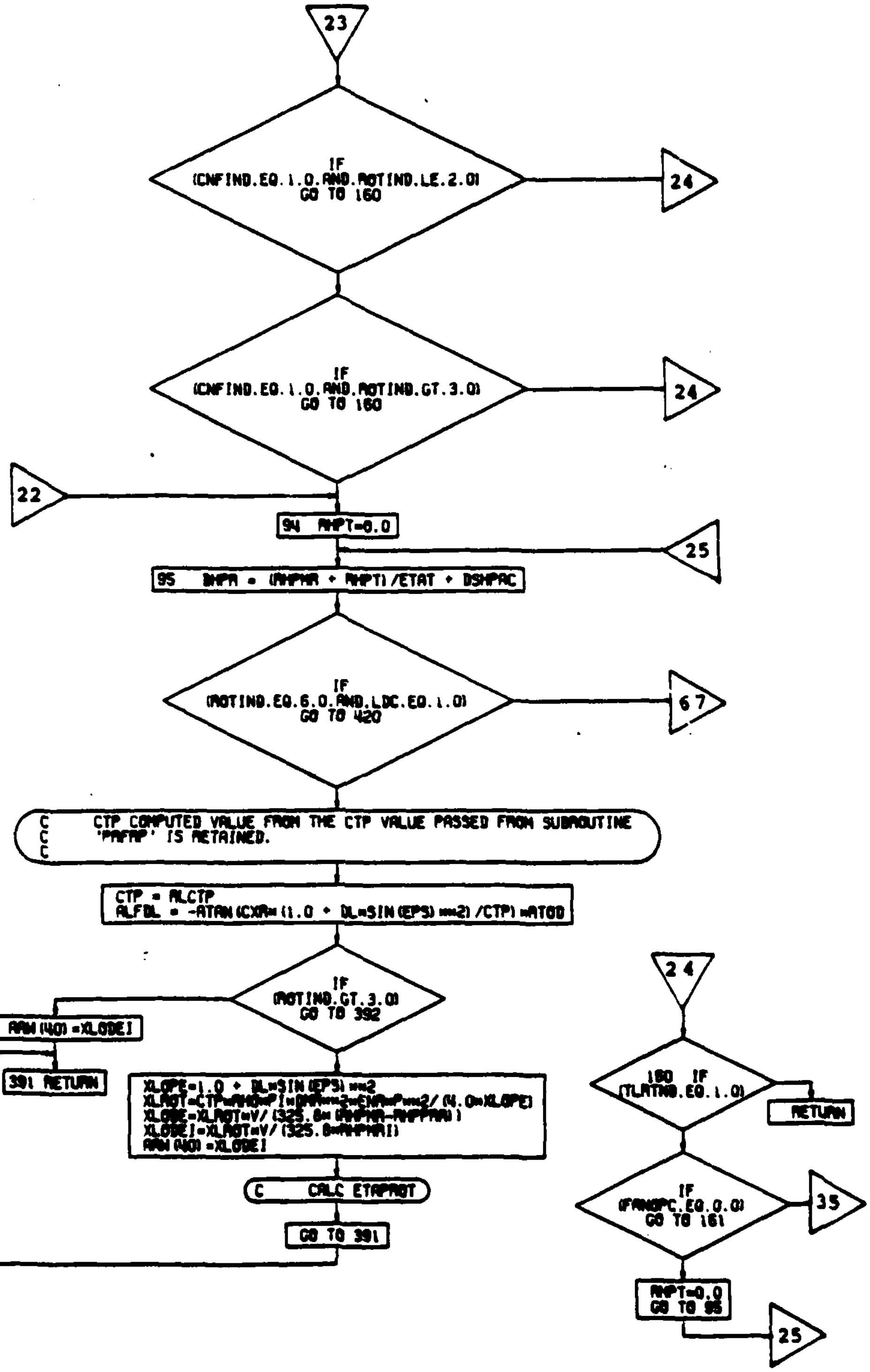


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 8 of 23)

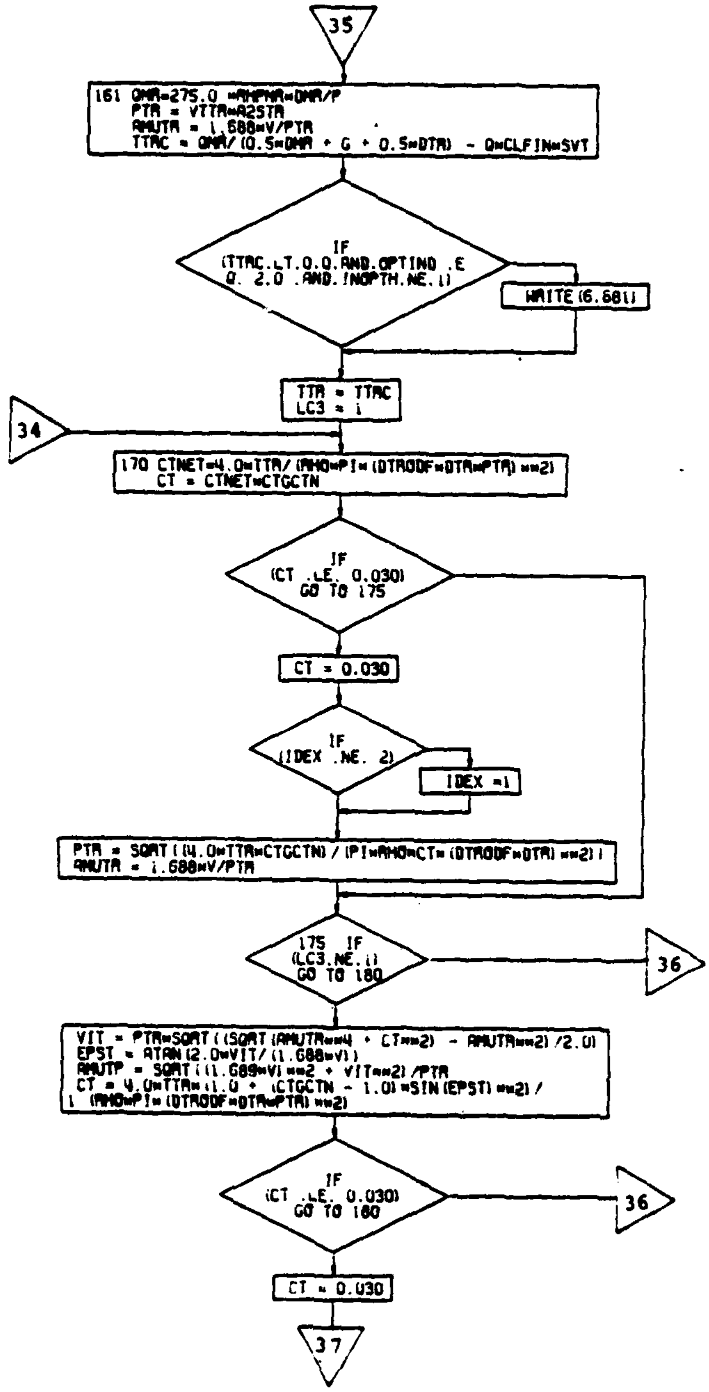


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 9 of 23)

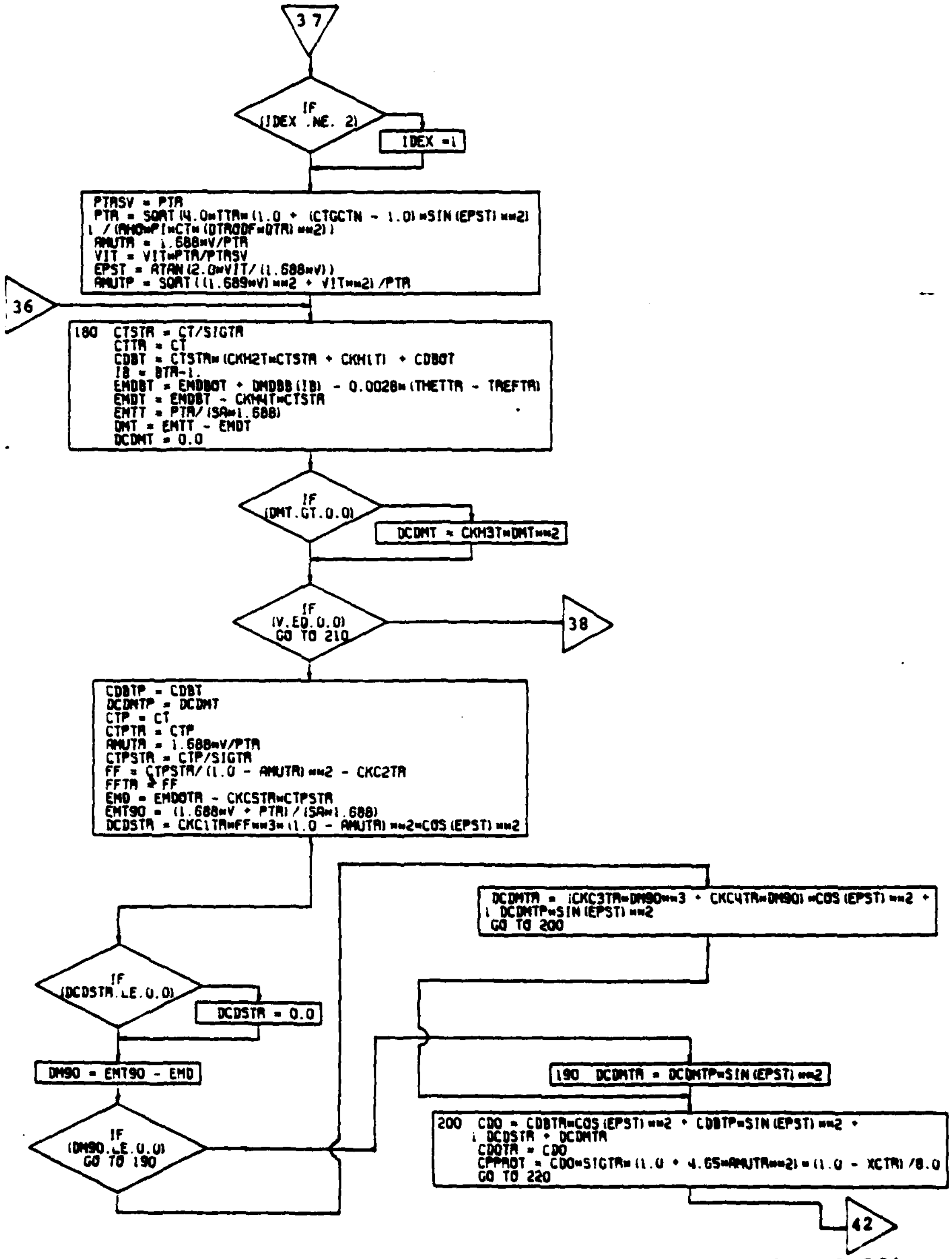


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 10 of 23)

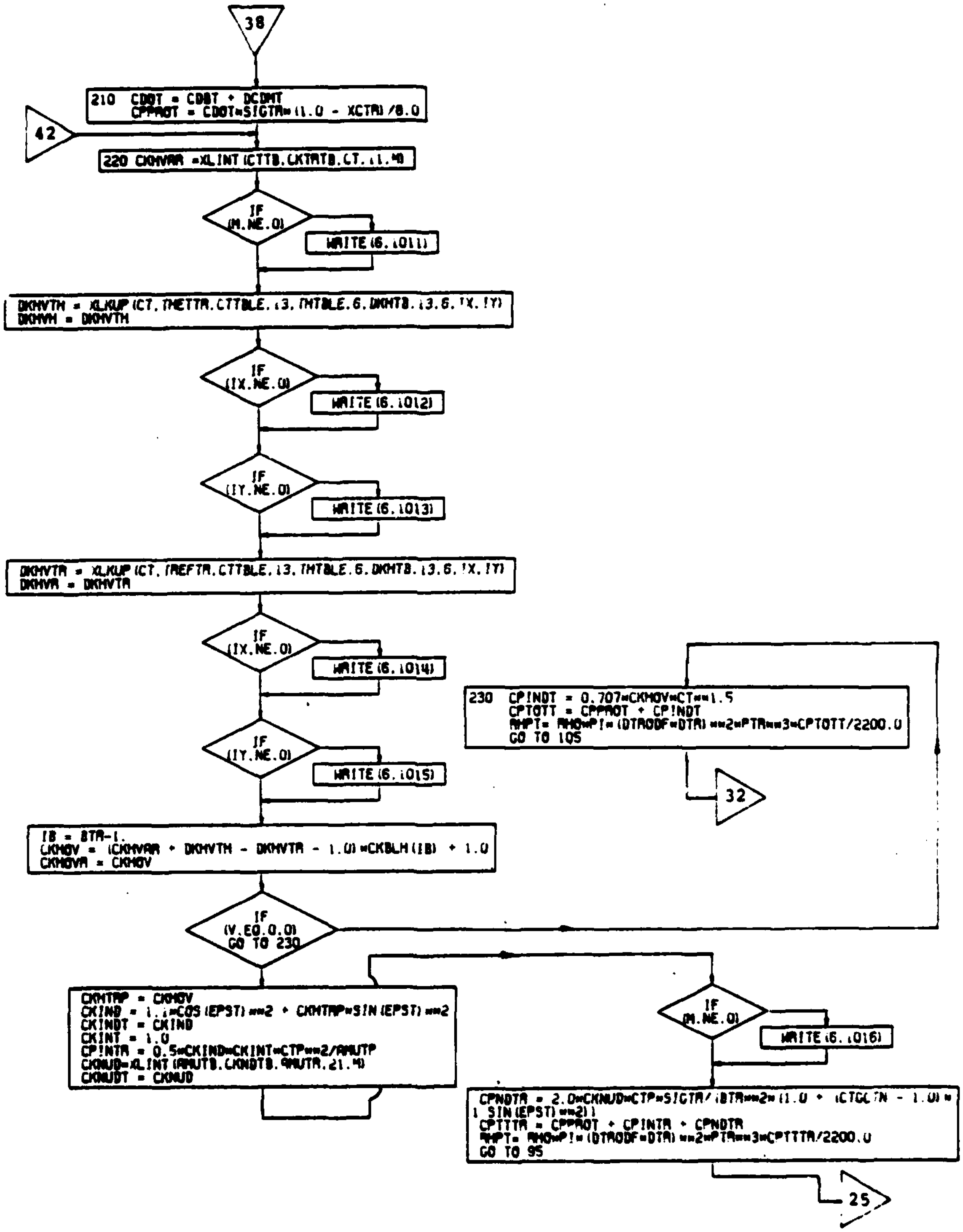


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 11 of 23)

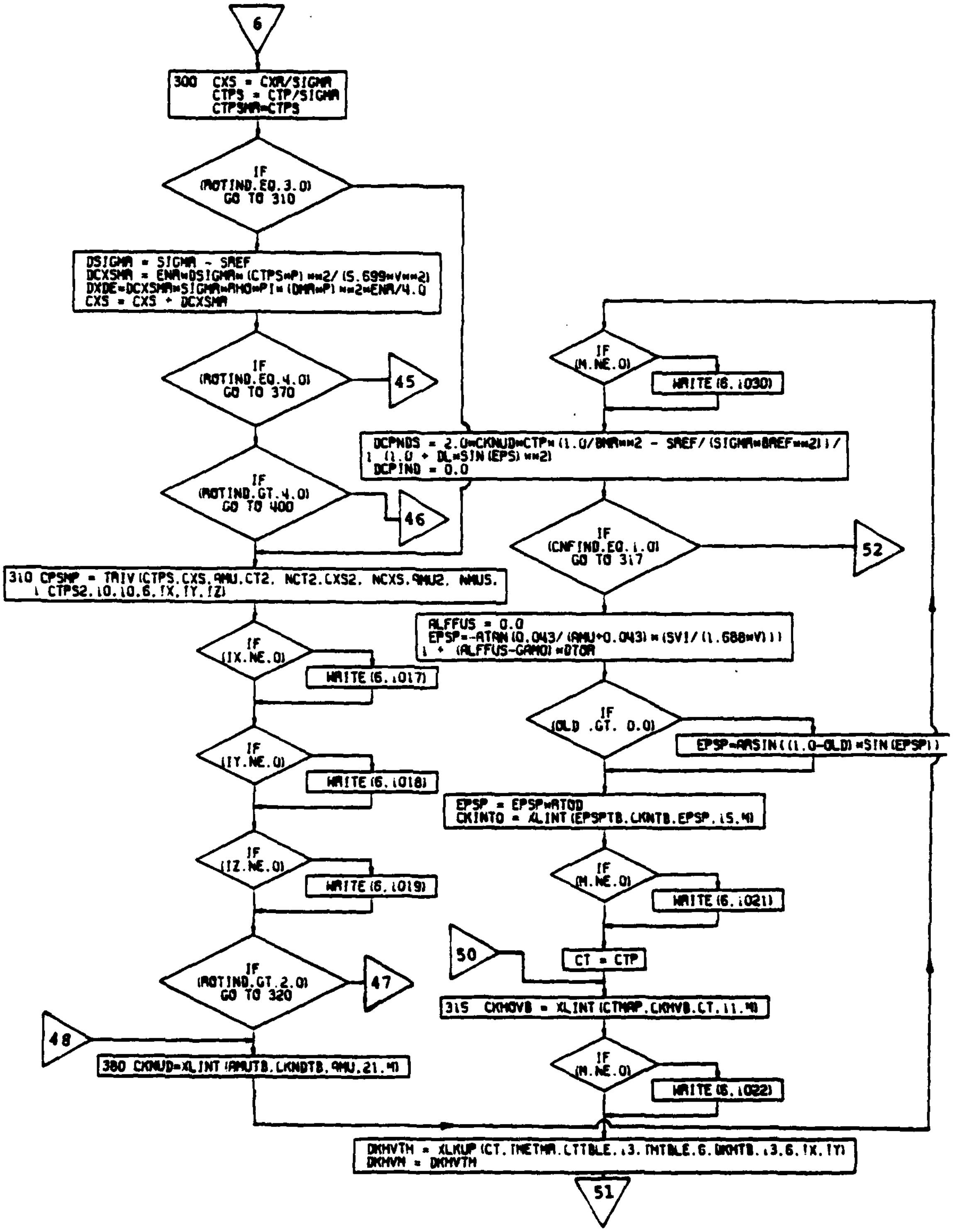


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 12 of 23)

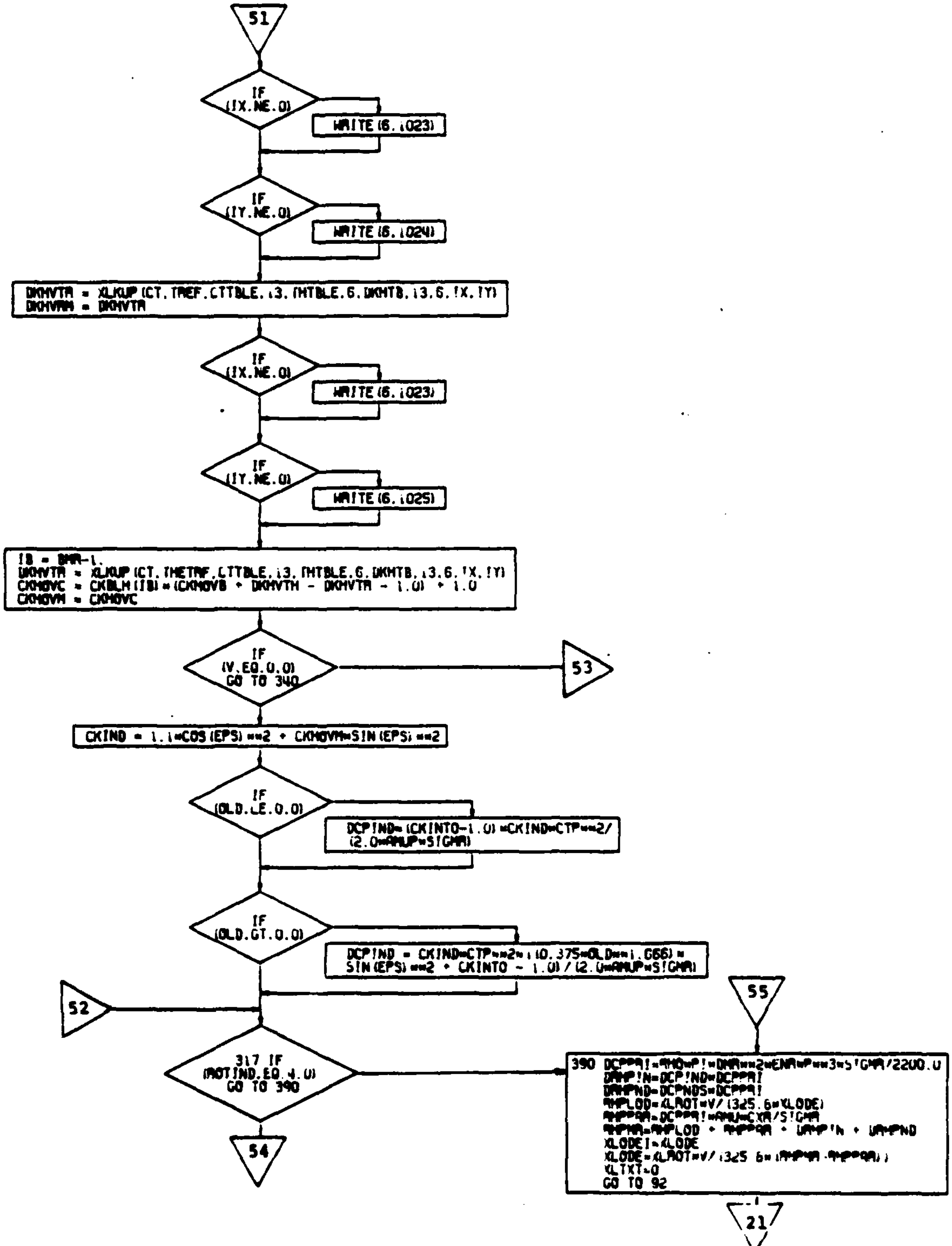


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 13 of 23)

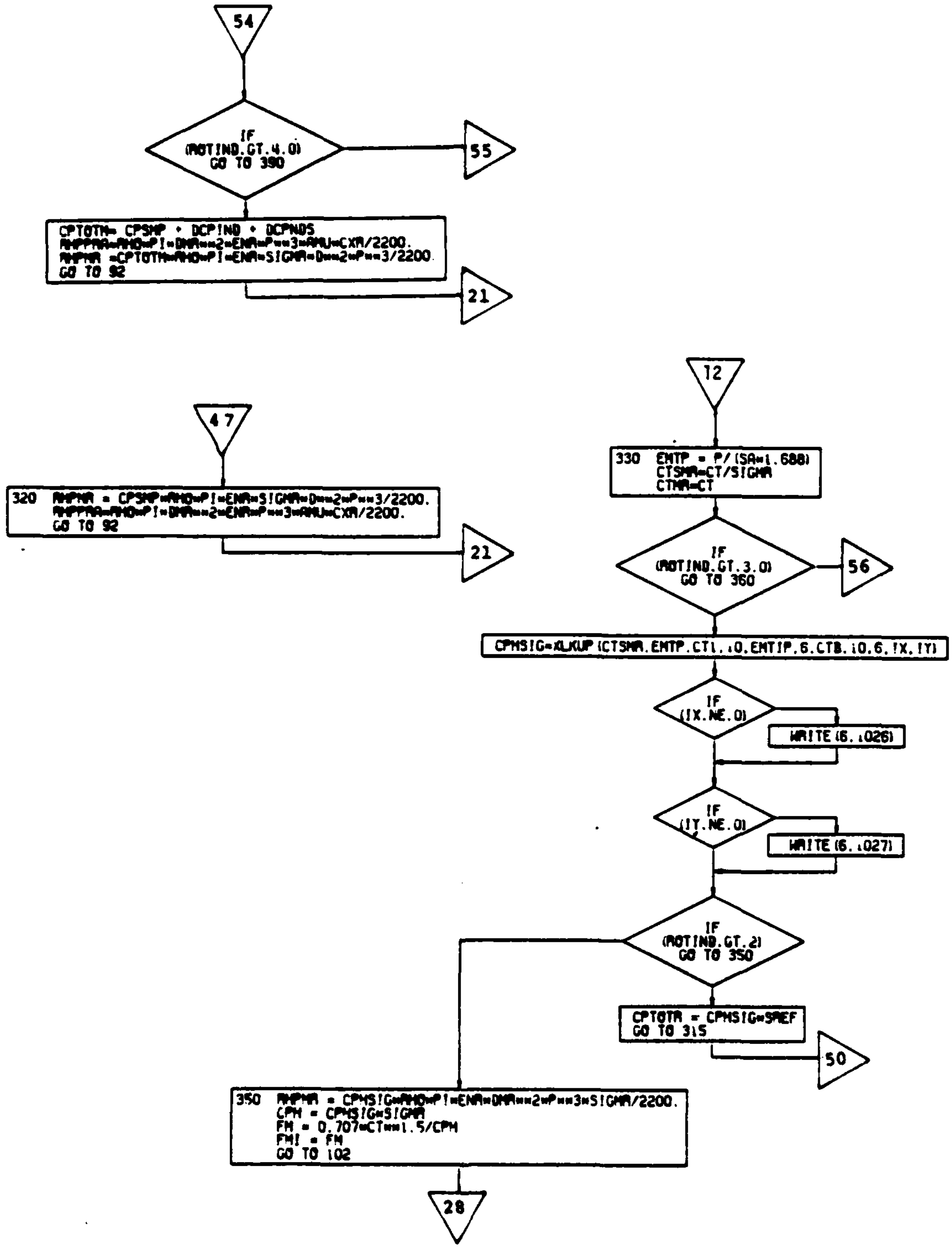


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 14 of 23)

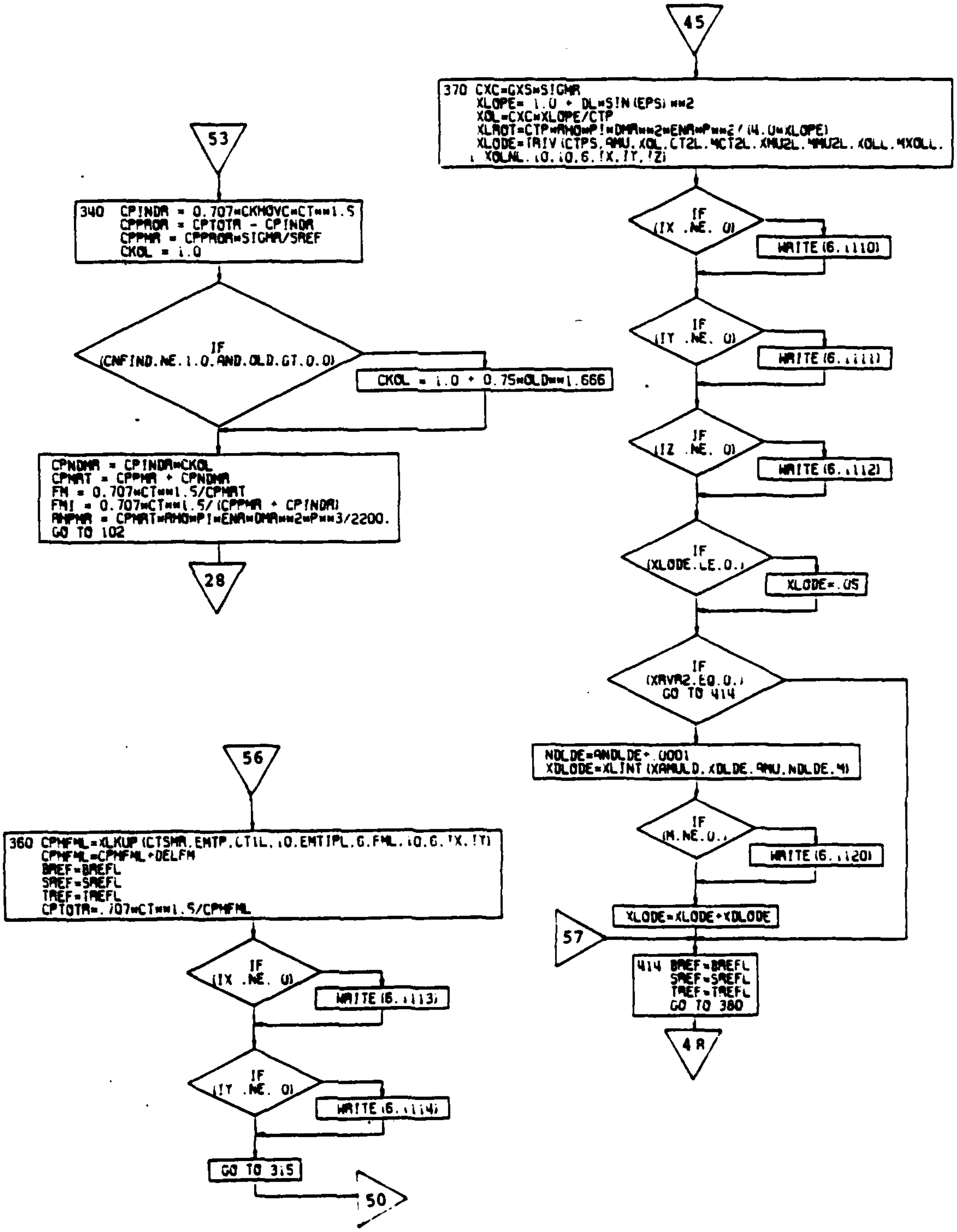


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 15 of 23)

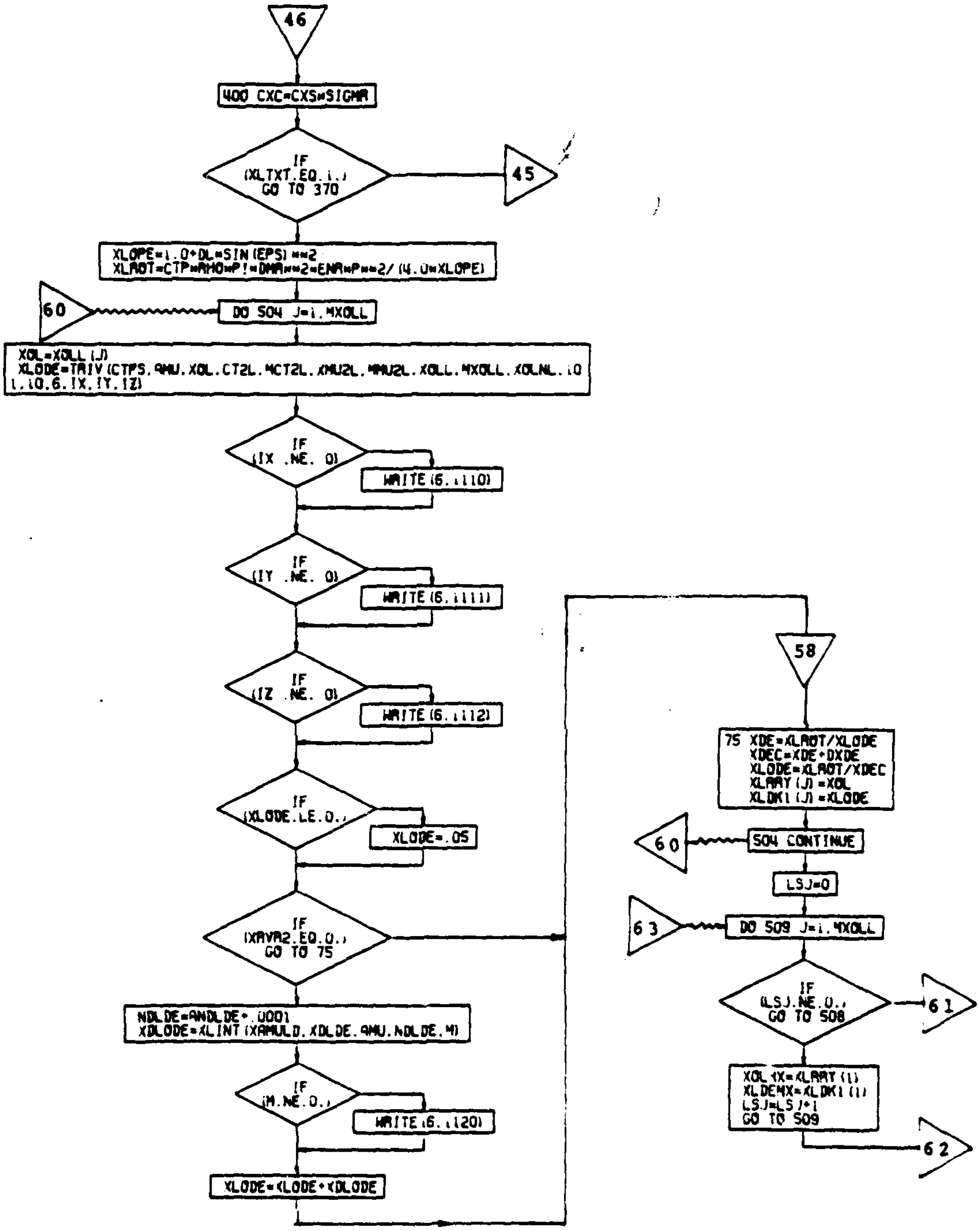


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 16 of 23)

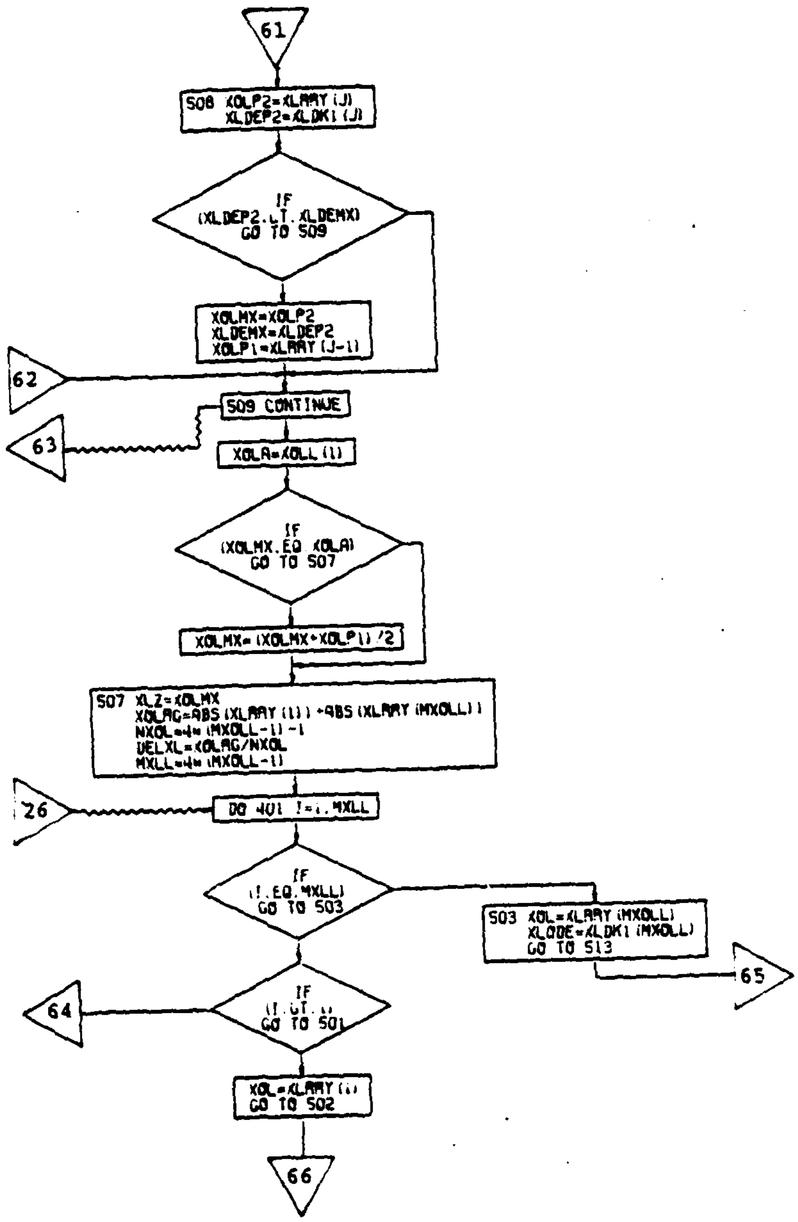


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 17 of 23)

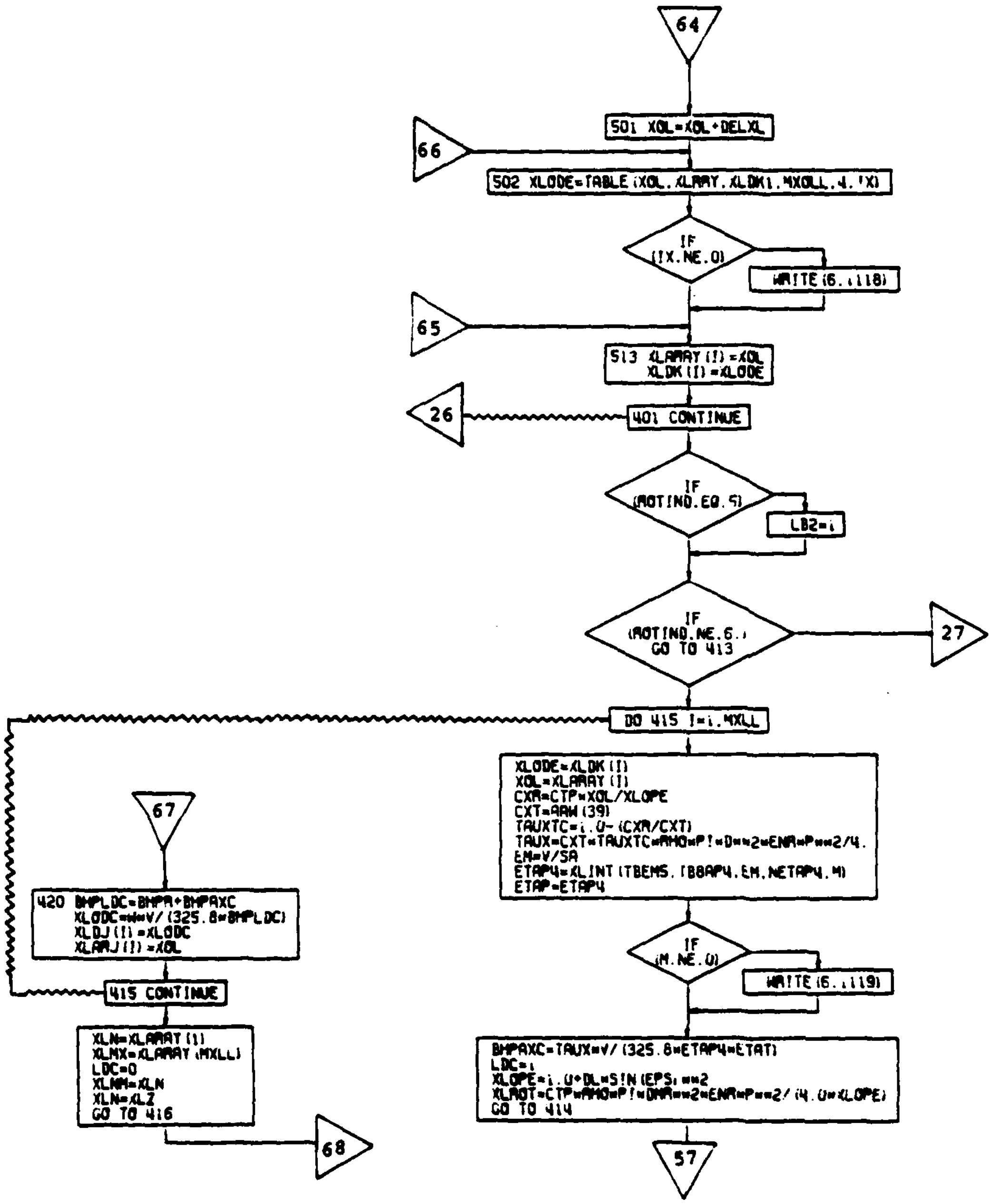


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 18 of 23)

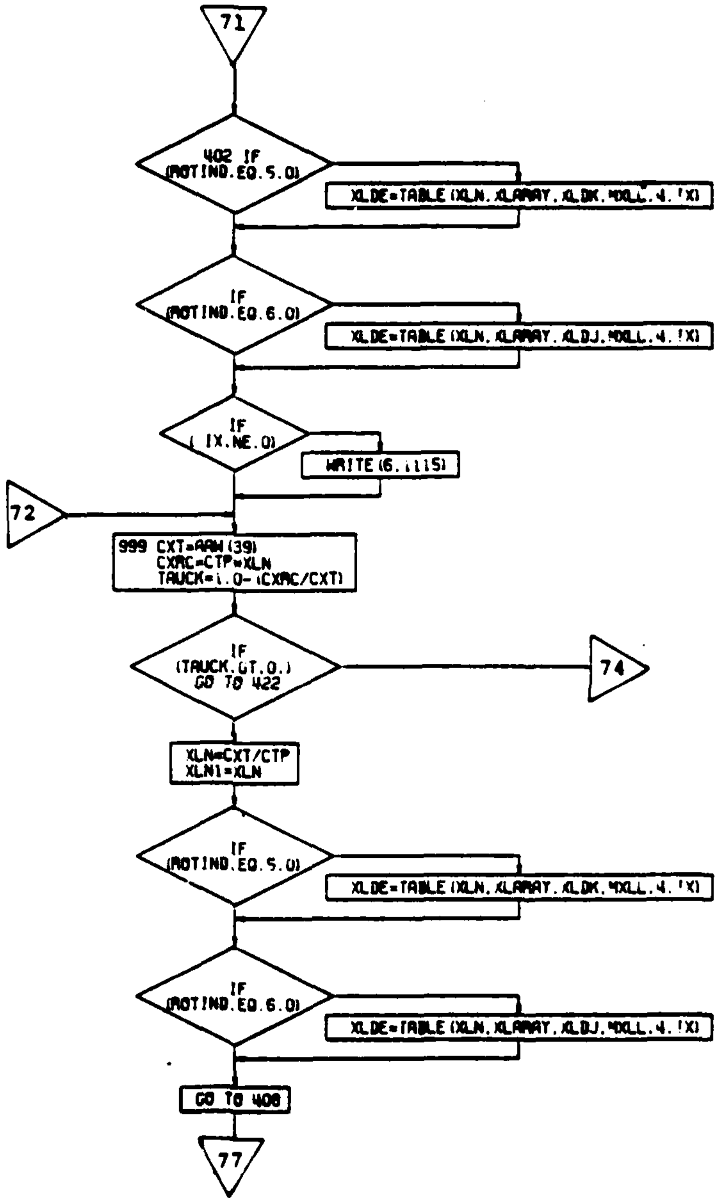


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 19 of 23)

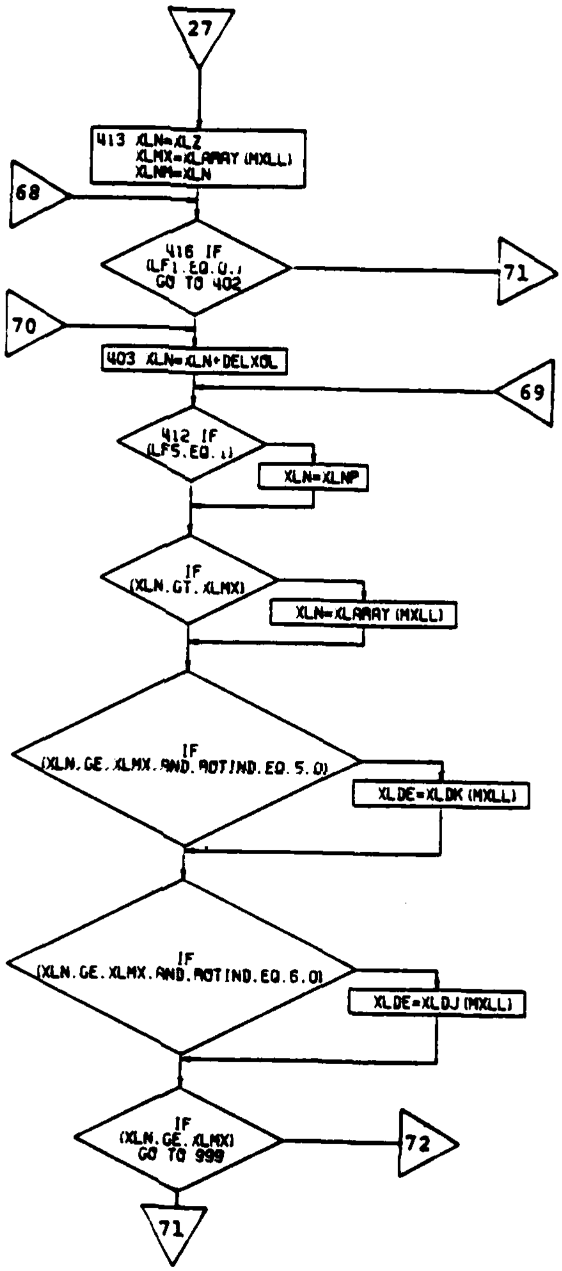


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 20 of 23)

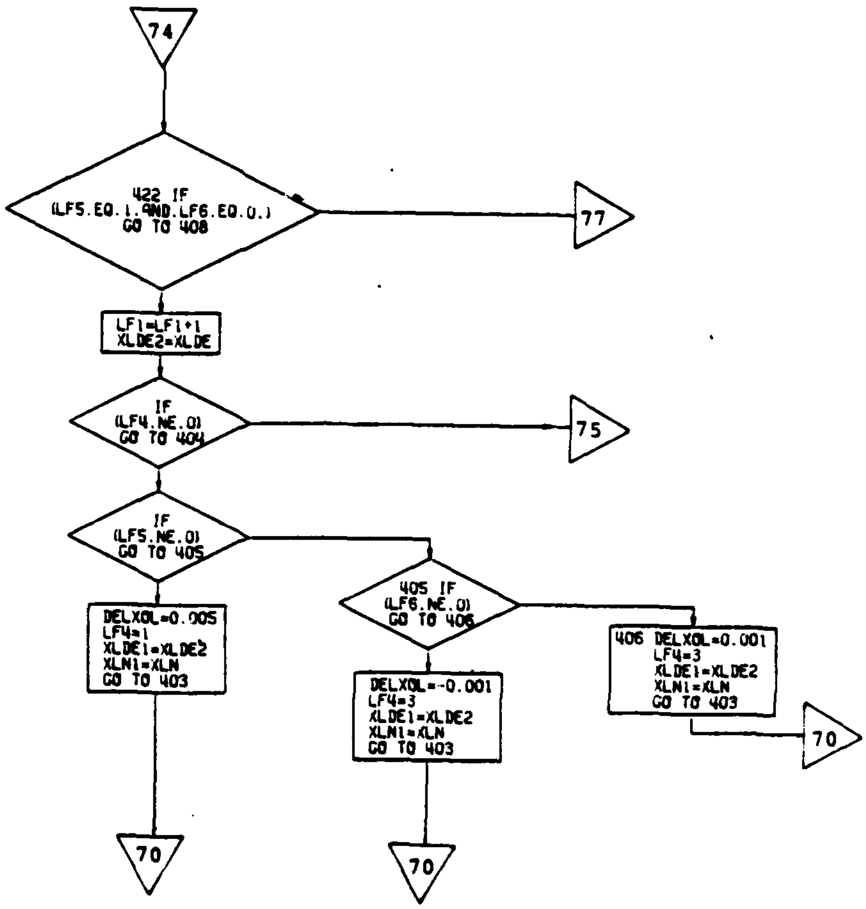


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 21 of 23)

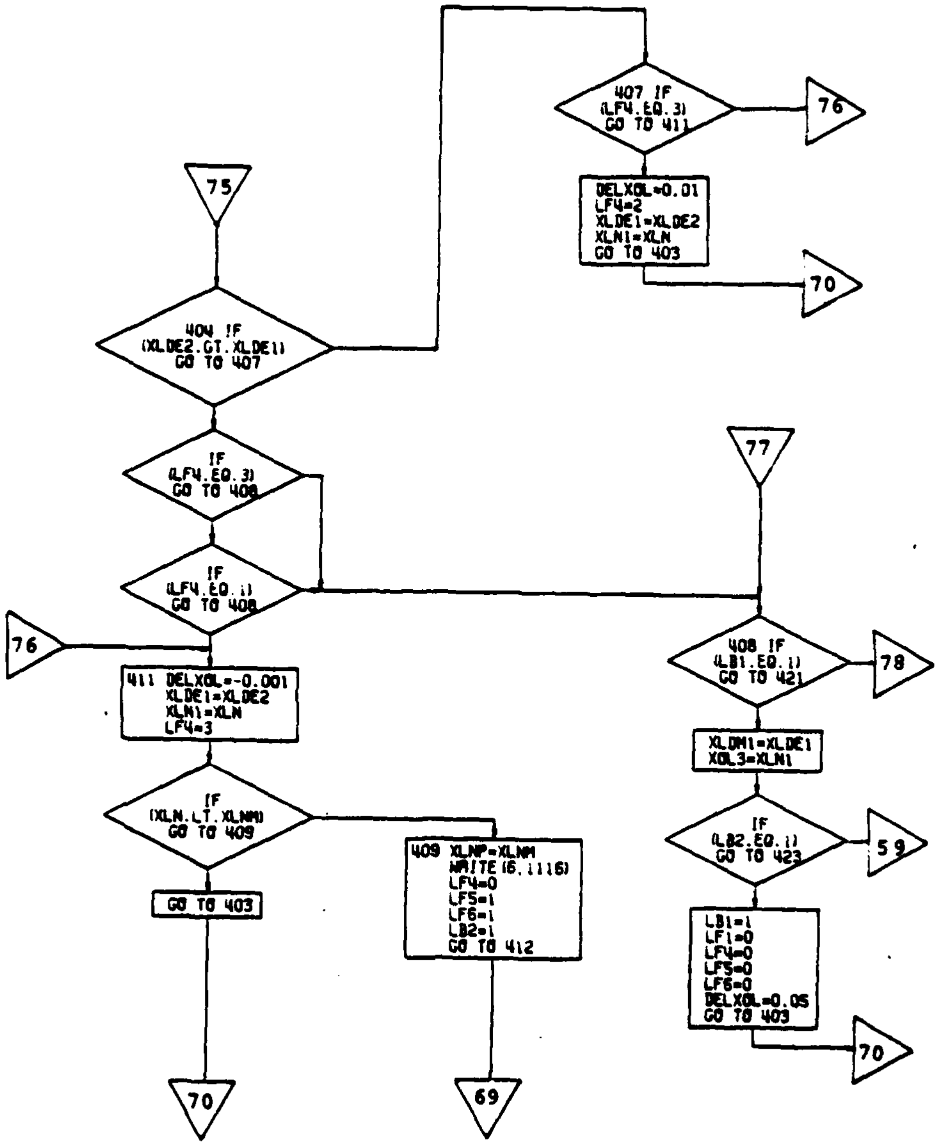


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 22 of 23)

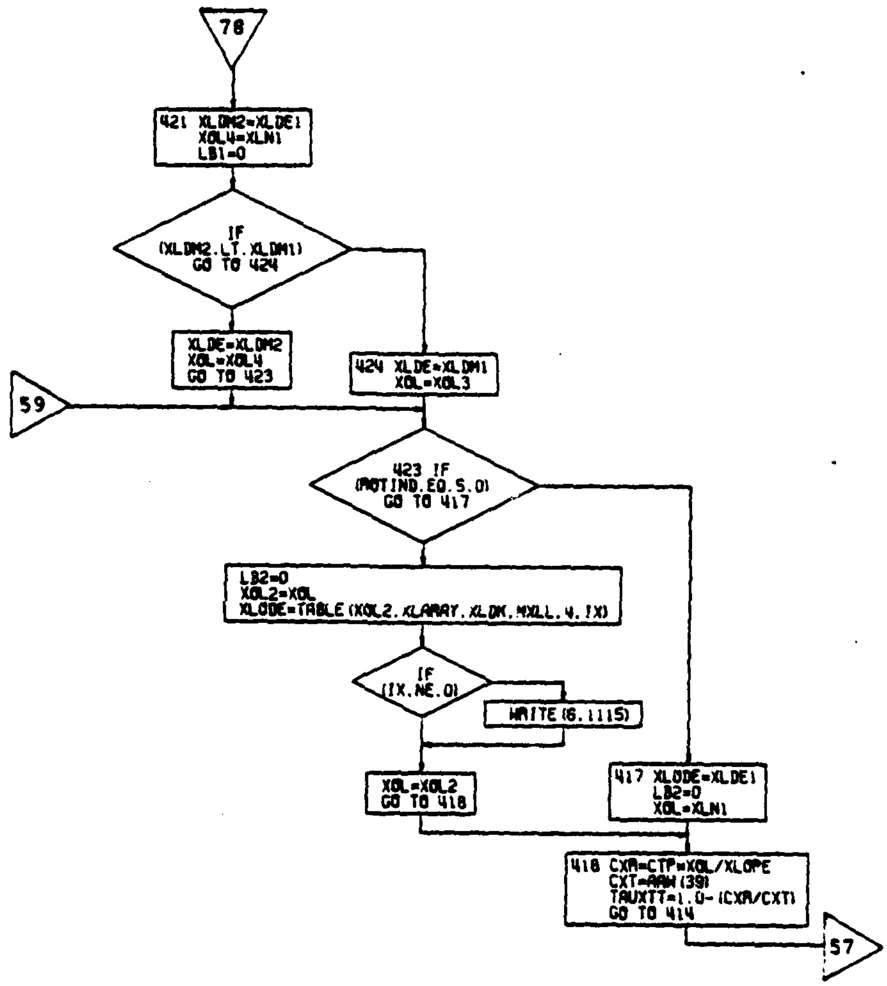


Figure 4-19. ROTPOW Subroutine, Flow Chart (Part 23 of 23)

4.6 ROTOR LIMITS SUBROUTINE

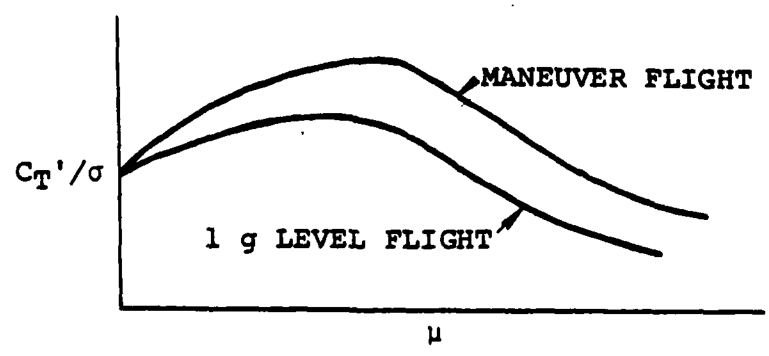
The rotor limits subroutine compares the main rotor operating values of μ, $\frac{C_{X_R}}{\sigma}$, and C_T'/σ to those input in the rotor limits information table (LOC 0347-0395). In the takeoff, hover, and landing subroutine, if the main rotor operating value of C_T'/σ exceeds the table value, the following statement is printed out:

WARNING: ROTOR LIMIT HAS BEEN EXCEEDED. EITHER REDUCE MAIN ROTOR THRUST REQUIREMENTS AT THESE OPERATING CONDITIONS, OR INCREASE MAIN ROTOR TIP SPEED. CHECK ALL VALUES OF C_T/SIGMA IN THIS PERFORMANCE LEG.

In the climb, cruise, descent, and loiter subroutines, if the main rotor operating value of C_T'/σ for a given $\frac{C_{X_R}}{\sigma}$ and μ exceeds the table value, cruise speed is reduced until the operating and table values of C_T'/σ coincide and the following message is printed out:

WARNING: ROTOR LIMIT HAS BEEN EXCEEDED. FORWARD FLIGHT SPEED HAS BEEN REDUCED ACCORDINGLY. CHECK ALL VALUES OF TAS, MU, C_T'/σ, AND CXR IN THIS PERFORMANCE LEG.

The function of the rotor limits table input is to provide realistic (1g) level flight boundaries for helicopter rotor operation. This is important because, although the rotor performance calculation (whether using rotor "cycles" or maps) reflects operation near stall through rapidly increasing power required levels, it would still be possible, using a greatly oversized engine, to operate in this region, even though in actual fact the rotor could be overstressed or subject to structural failure. A typical rotor limits plot is illustrated by the sketch below:



For purposes of defining the tabular rotor limits input, the level flight conditions are of interest only, although single point values $(C_T/\sigma)_H$, $(C_T/\sigma)_{CR}$ from the maneuver flight curve are necessary for determining (sizing) main rotor solidity. Rotor limits then can be based on:

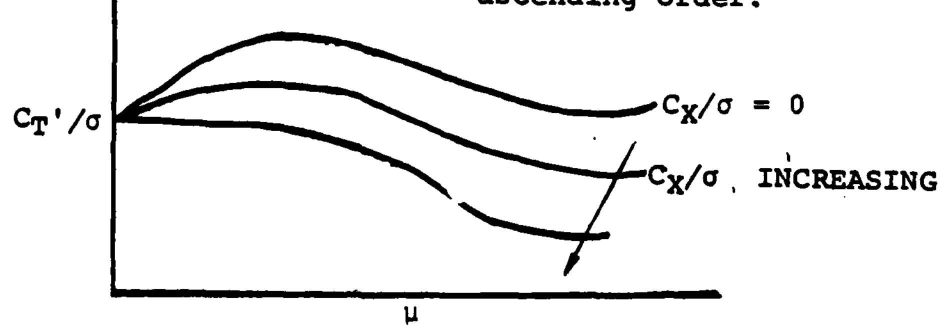
a) incipient rotor blade stall limits (1g level flight), or

b) incipient rotor blade stall and/or rotor blade structural limits for maneuver flight.

Figure 4-20 shows a summary of miscellaneous rotor limits data (theoretical and flight test), for both the 1g level flight and maneuver conditions. The rotor limit value $(C_T/\sigma)_H$ encountered in hover is typically due to stall flutter. This is primarily an aeroelastic/control system stiffness problem. Level flight rotor limit values, as noted earlier, are a function of incipient stall and/or stall flutter. Rotor limits in maneuver flight are more complex to understand because of the interaction of various rotor configurations and rotor parameters on the result. For example, a rotor system with relatively high rotor blade inertia in the flapwise direction should potentially (in a maneuver) exhibit a higher maneuver g capability (due to gyroscopic precessional effects) than a rotor with less inertia in the flapwise direction. Other factors influencing rotor limits include the torsional natural frequency of the blade as it interacts with stall flutter, chordwise bending stresses of the blade, the type of maneuver performed, etc. For a more detailed discussion of this matter, see References 12 to 15.

Provision has been made in the rotor limits table for inclusion of rotor limits which are a function of C_X/σ (based on rotor propulsive thrust) as well as μ (see the sketch below).

NOTE: Values of C_X/σ and μ must be in ascending order.



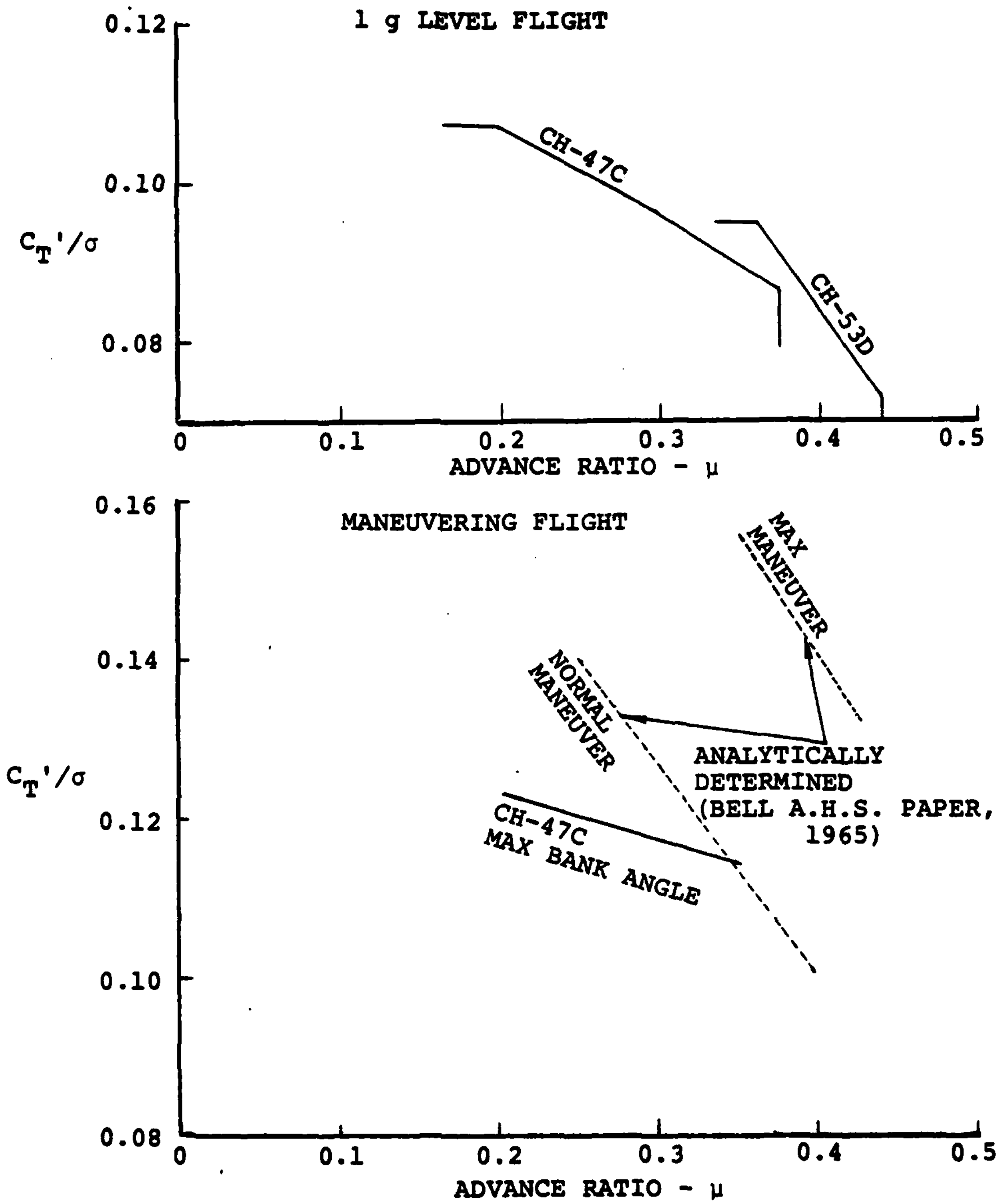


Figure 4-20. Summary of Typical Rotor Limits.

In those instances where C_X/σ is not a variable, the user simply inputs C_T'/σ versus μ at dummy values of C_X/σ (0 and 1.0). If the user wishes to operate the program without using rotor limits, large "dummy" values of C_T'/σ (say 1.0) are input at C_X/σ = 0 and 1.0.

Figure 4-21 is a flow chart of this subroutine.

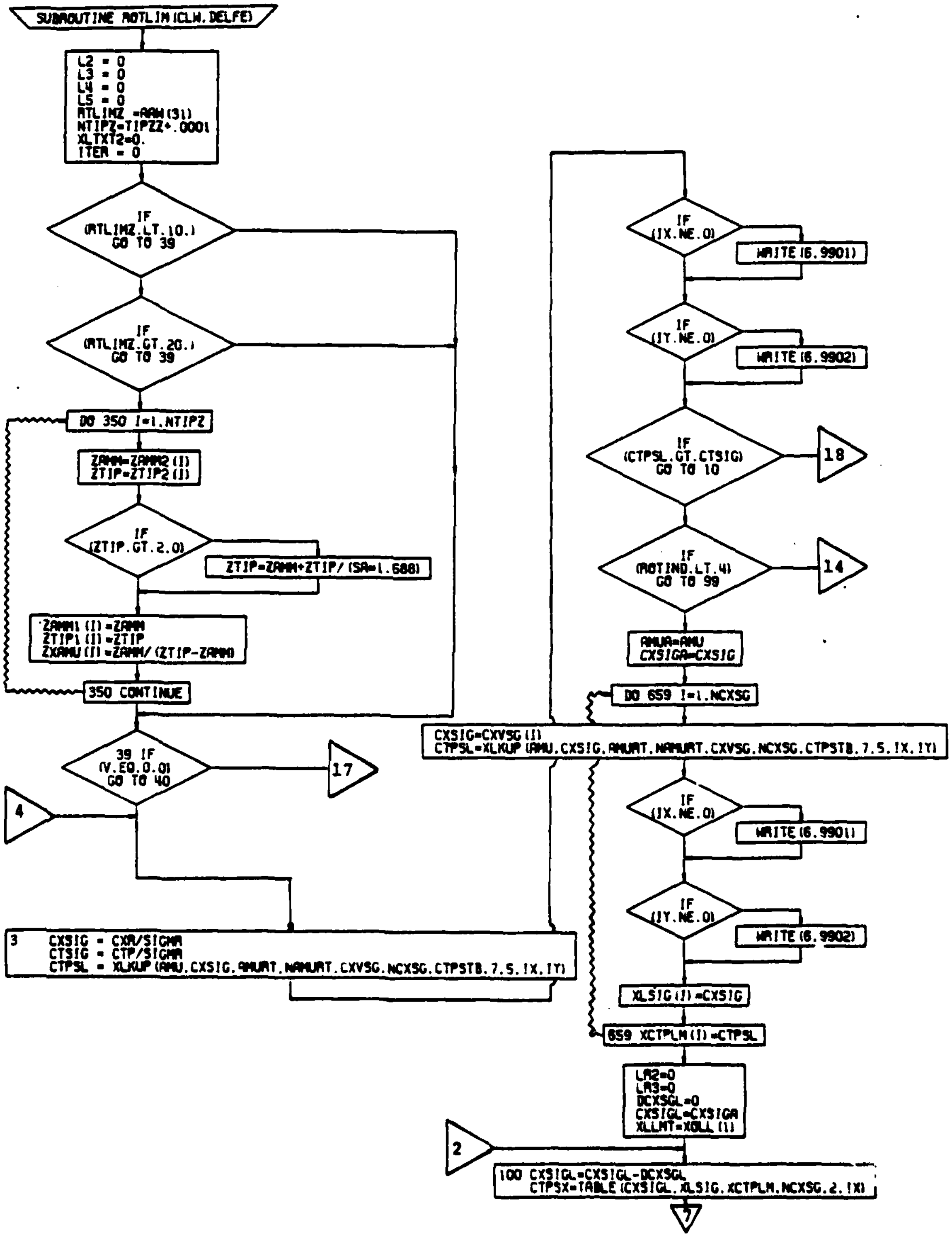


Figure 4-21. ROTLIM Subroutine, Flow Chart (Part 1 of 7)

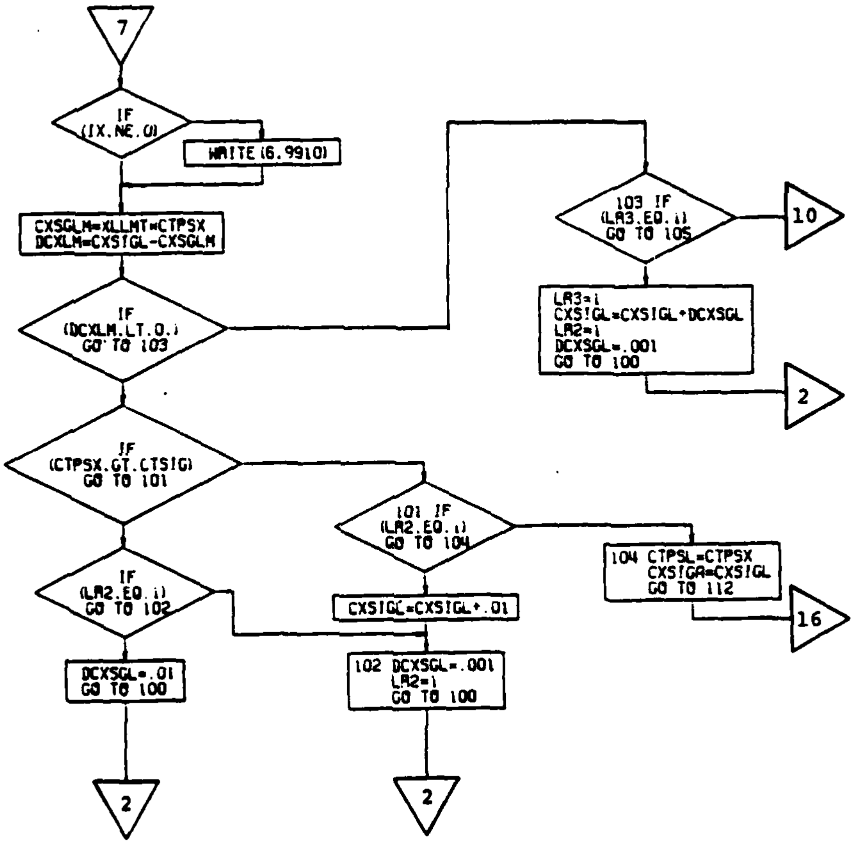


Figure 4-21. ROTLIM Subroutine, Flow Chart (Part 2 of 7)

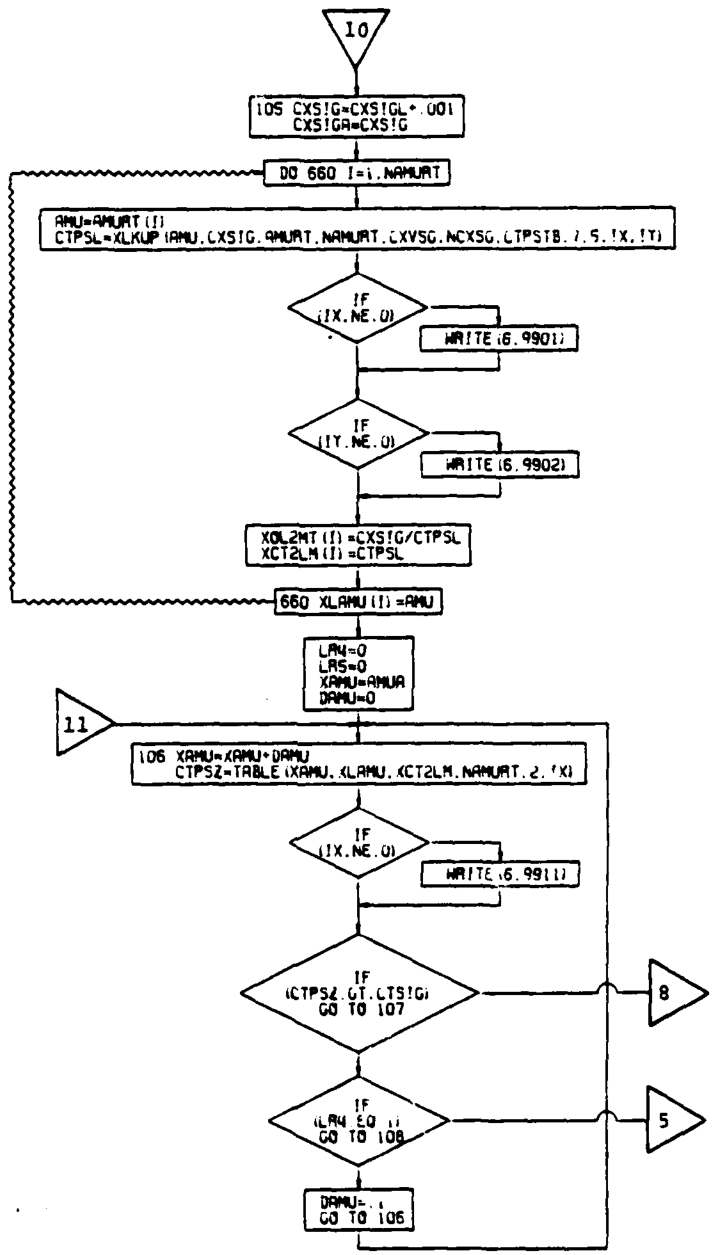


Figure 4-21. ROTLIM Subroutine, Flow Chart (Part 3 of 7)

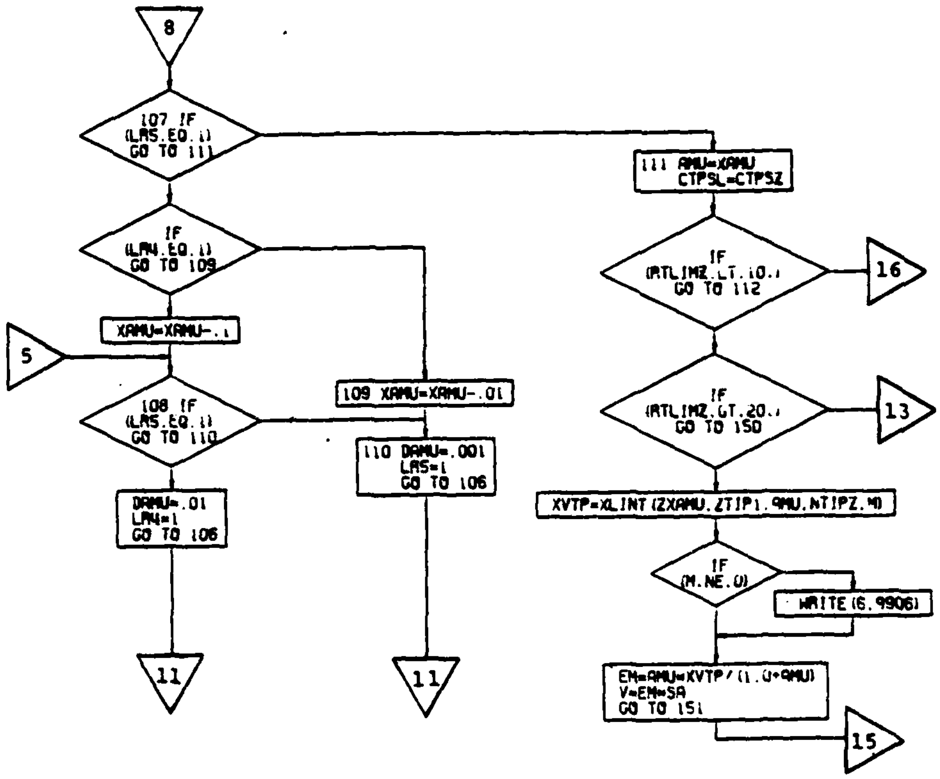


Figure 4-21. ROTLIM Subroutine, Flow Chart (Part 4 of 7)

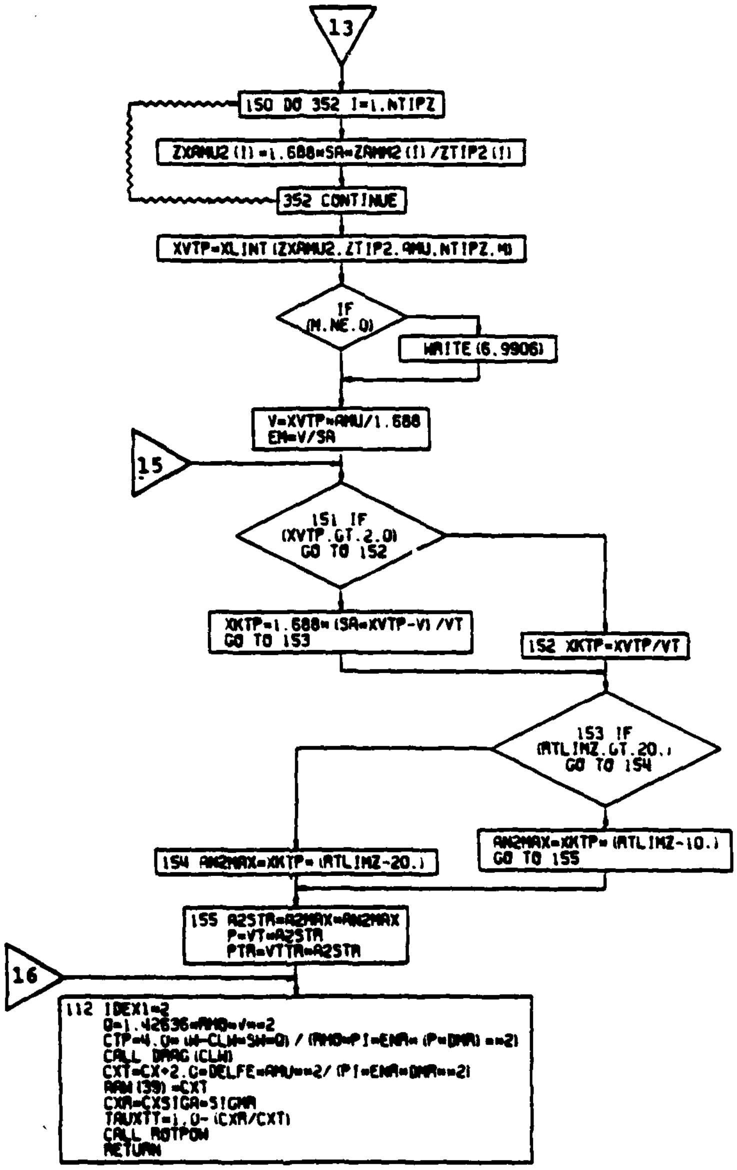


Figure 4-21. ROTLIM Subroutine, Flow Chart (Part 5 of 7)

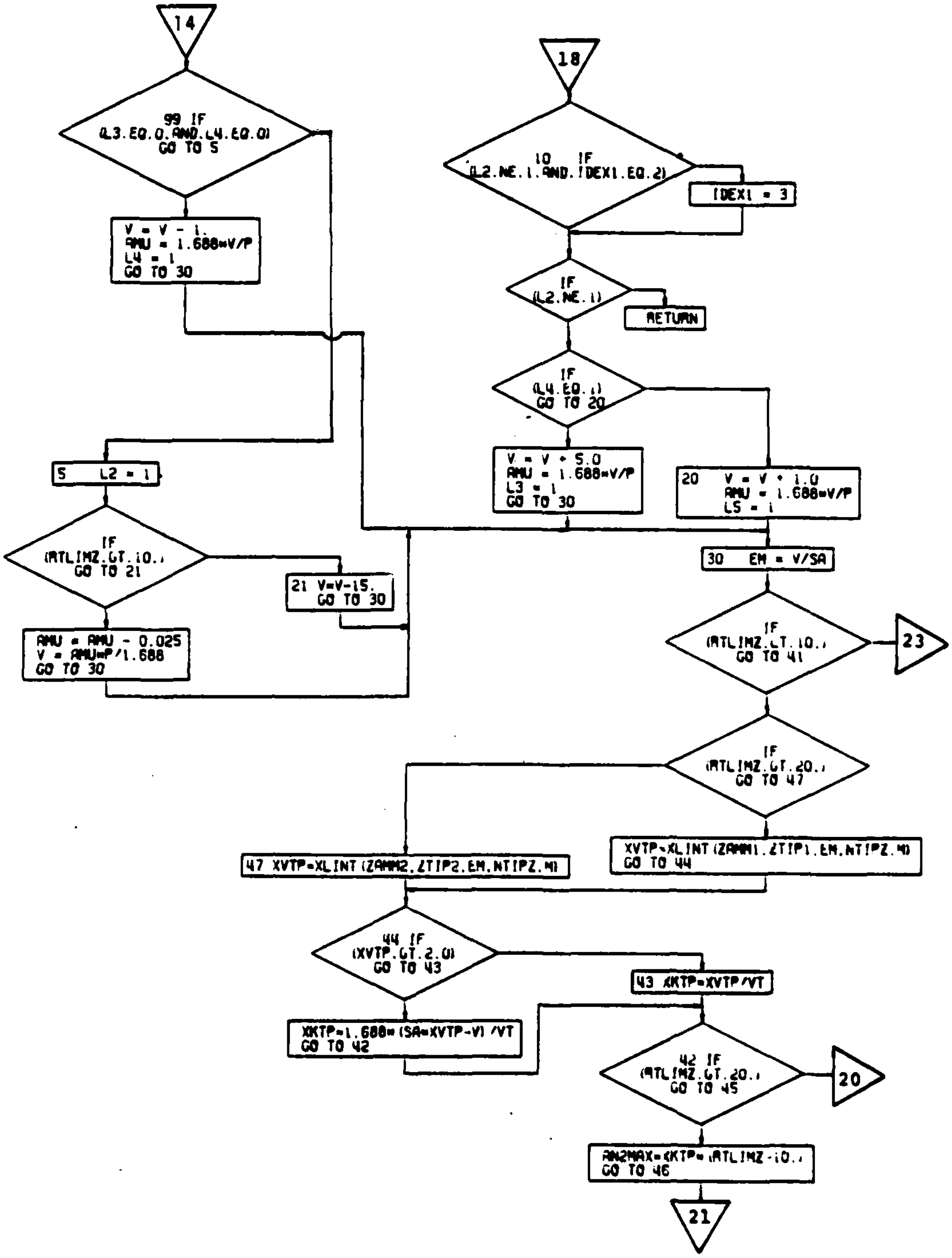


Figure 4-21. ROTLIM Subroutine, Flow Chart (Part 6 of 7)

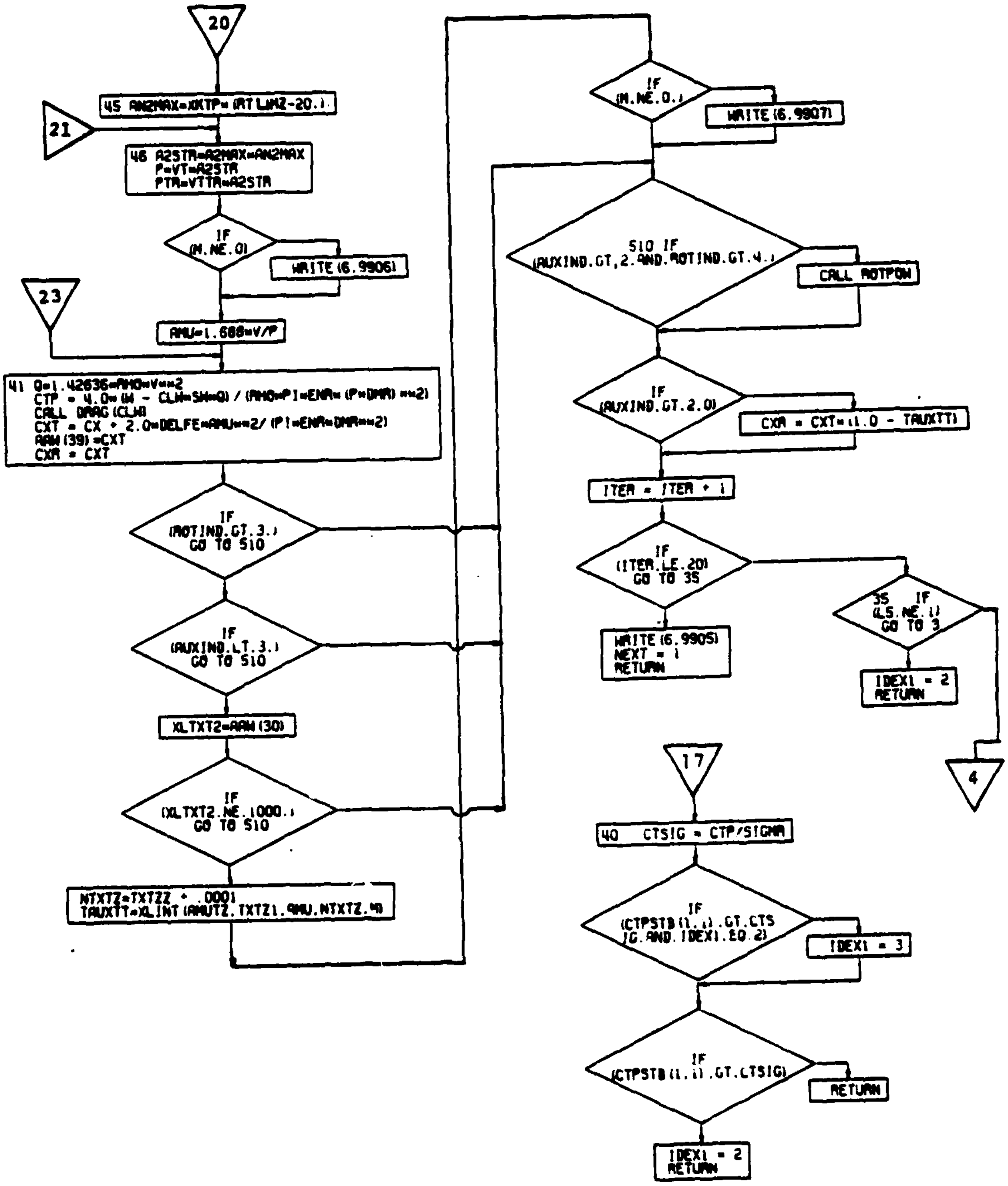


Figure 4-21. ROTLIM Subroutine, Flow Chart (Part 7 of 7)

4.7 PROPELLER PERFORMANCE CALCULATIONS

The final selection of a propeller blade design to best suit a given compound helicopter mission is a rather arduous task because the suboptimization of many considerations, such as propeller efficiency, propeller weight, power transmission system weight, powerplant performance, and others, is required for each mission segment followed by an overall mission optimization. A single propeller design does not satisfy the requirement.

The basic problem faced in evolving a single propeller design to satisfy all flight conditions is that of achieving the optimum blade loading for each of the flight conditions. This is virtually impossible due to the degree and manner in which thrust required and power available vary with engine and vehicle speeds. From an aerodynamic viewpoint, this basic problem manifests itself in terms of problems associated with blade chord, twist and design C_L distributions, engine-propeller performance matching, and compressibility.

Propeller blade loading is a function of the spanwise distribution of blade twist, blade chord, and blade section design lift coefficient. These three parameters must be employed so as to yield the optimum propeller performance at a given flight condition. This will occur when each section of the blade is adjusted to operate at or near its maximum lift-drag ratio while maintaining an optimum spanwise load distribution. As the operating conditions vary, the degree to which near optimum conditions can be maintained changes for a fixed blade geometry. Therefore, some compromise must take place, and best efficiency cannot achieved at each and every operating condition.

As one can appreciate, with fixed blade geometry the attainment of overall propeller optimization is somewhat limited with regard to what can be aerodynamically achieved with twist, solidity, and design lift coefficient. Furthermore, changing these variables results in variations in blade centrifugal twisting moment, hub centrifugal loads, blade pitch control loads, and numerous other items which result in either operational envelope limitations or weight constraints. Variable blade geometry can result in aerodynamic improvements, but these may well be offset by increased weight and cost. Variable geometry propeller blade development and application, furthermore, have been quite limited.

The ability to alter propeller speed in cruise will help the designer cope with blade loading problems and result in better mission efficiency. This can be done whether by using a multiple speed power transmission system between the engine and propeller or by exercising the variable output shaft speed capability of free turbine powerplants. The former method is generally not used due to weight penalties, while the latter

method is extensively employed. Engine-propeller matching, though, is not as simple as it may sound. Engine power does fall off at nonoptimum turbine speed, and transmission torque requirements and weight increase with reduced turbine speed.

The combination of vehicle speed, propeller speed, diameter and altitude produce a constraint in the form of Mach number. Exceeding a helical tip Mach number of about 0.95 appears to significantly reduce propeller efficiency.

Current state of the art regarding propeller aerodynamics appears to permit very accurate appraisal of a given propeller design performance over most of the flight envelope. Performance prediction capability is generally inadequate in the following areas: 1) static thrust, 2) at moderate to high propeller shaft angles of attack (say 30 to 90 degrees), and 3) under the "mixed" flow conditions where the blade sections are in neither wholly subsonic nor wholly supersonic flows. For purposes of preliminary design, however, the short methods for predicting propeller performance available from propeller manufacturers (e.g., Curtiss-Wright and Hamilton Standard) generally produce acceptable results, and should certainly be given consideration.

Whenever possible, the aircraft designer should consult the propeller manufactures' and his own propeller staffs early in the preliminary design phase. Lacking this, he should freely exercise the methodology published by propeller manufacturers. These methods require only several minutes to manually compute a propeller performance point and are well worth the effort. Too many preliminary aircraft designs have proceeded too far assuming propeller efficiencies in excess of the ideal induced (i.e., zero drag) value.

Three different options are available for representing the performance of propellers when using turboshaft engines (ENGIND = 0). The option to be used is specified to the program by means of a prop efficiency indicator - "η_pIND".

<u>η_pIND = 0</u> - The user inputs a set of point values for the prop efficiency for the performance segments of climb and descent and a table of efficiency as a function of flight Mach number for cruise and loiter. The following input is required:

- η_{P2} - The static propeller efficiency (Figure of Merit) to be used in calculation of Takeoff, Hover and Landing (SGTIND=2) is input as a single point value. It should be noted that η_{P2} is also a required input for jet engines (ENGIND=1) or for convertible engines (ENGIND=2). In the former case η_{P2} may be used to represent the turning efficiency of jet engines being

used with turning vanes. In the latter case it represents the Figure of Merit of the props or rotors being used with the convertible engines.

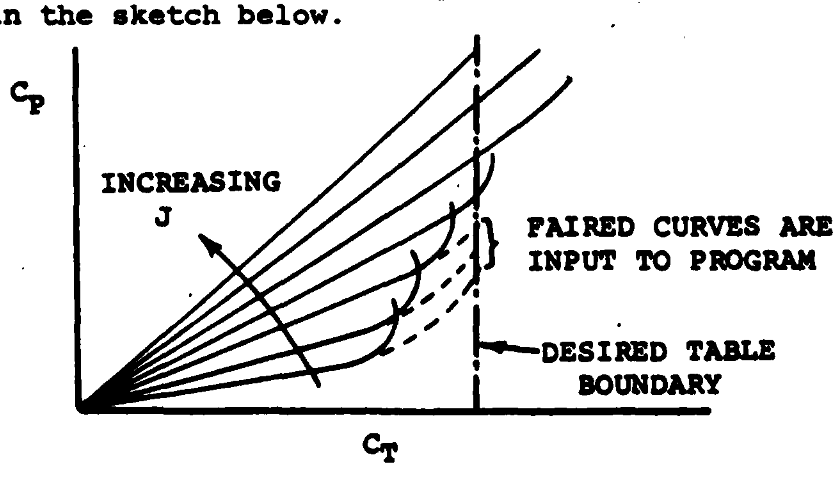
η_{P3} - A single point value is input for the prop efficiency during climb (SGTIND=3).

η_{P4} - A table is input of prop efficiency during cruise (SGTIND=4) and Loiter (SGTIND=6) as a function of flight Mach number.

η_{P5} - A single point value is input representing the prop efficiency during Descent (SGTIND=5).

The primary advantage of this option of propeller performance representation is that it permits rapid evaluation of the sensitivity of aircraft performance and size to changes in propeller performance. For example, a series of runs with different values of η_{P2} and η_{P4} will quickly show the tradeoff between Figure of Merit and cruise efficiency for a family of propellers. It may also prove desirable to use this option in early conceptual studies when a specific prop has not been picked and it is desired to use "reasonable" values of efficiency.

η_pIND = 1 - This option permits the user to input a table representing the performance of the propeller throughout the flight envelope with the exception of DESCENT (SGTIND = 5) for which a value of η_{P5} is input as before. For all other performance segments the table, input in the format of Cp (prop power coefficient) as a function of C_T (prop thrust coefficient) and J (advance ratio), is used. The table which is prepared must include all compressibility losses for the known tip speed at which the propeller is intended to operate. The user is cautioned that the tabular values must be monotonic. That is, the table cannot include the maximum in C_T which reflects blade stall at high values of C_p. This must be faired out as shown in the sketch below.



The advantage of this option is that it permits the user to input the performance of a real propeller as determined from test data.

$\underline{\eta_p \text{IND} = 2}$ - Through use of this option the program will automatically calculate the performance of a wide variety of V/STOL propellers. The user need only specify the number of blades (3 or 4), the activity factor per blade, and the integrated lift coefficient, C_{L_i}. The method used for the calculation of propeller performance is the "short method" originated at the Curtiss-Wright Corporation's Propeller Division (Reference 10). The method involves the use of a set of equations which can be developed from strip theory. These equations permit the propeller performance maps (C_p, C_T, J) to be transformed into an "equivalent" lift-drag polar for the propeller. Conversely, the lift-drag polars, once developed, can be used with the equations to predict the propeller performance. For incompressible flow, the "equivalent" lift-drag polar which is used depends only on the value of C_{L_i} being considered. That is, for a given C_{L_i} the same polar can be used to accurately represent the performance of props with a wide variation in activity factor and number of blades and for a wide range of C_p and J. For compressible flow conditions, the curves correlate very well on the basis of the value of helical Mach number at the 3/4 radial station. The equivalent lift-drag polars which are contained in the program were developed from detailed strip analysis calculations for cruise. These detailed calculations covered the following range of parameters:

Number of blades:	3 and 4
Activity factor/blade:	60 - 220
Integrated lift coefficient, C_{L_i} :	0.15 - 0.7

Although the user is permitted to input values of activity factor and C_{L_i} greater than (or less than) those shown above, the level of confidence in the predictions is reduced when values for those parameters are outside the range used in the detailed calculations.

Figures 4-22a and 4-22b are characteristic of the level of accuracy obtained from the short ethod when compared to the detailed calculations.

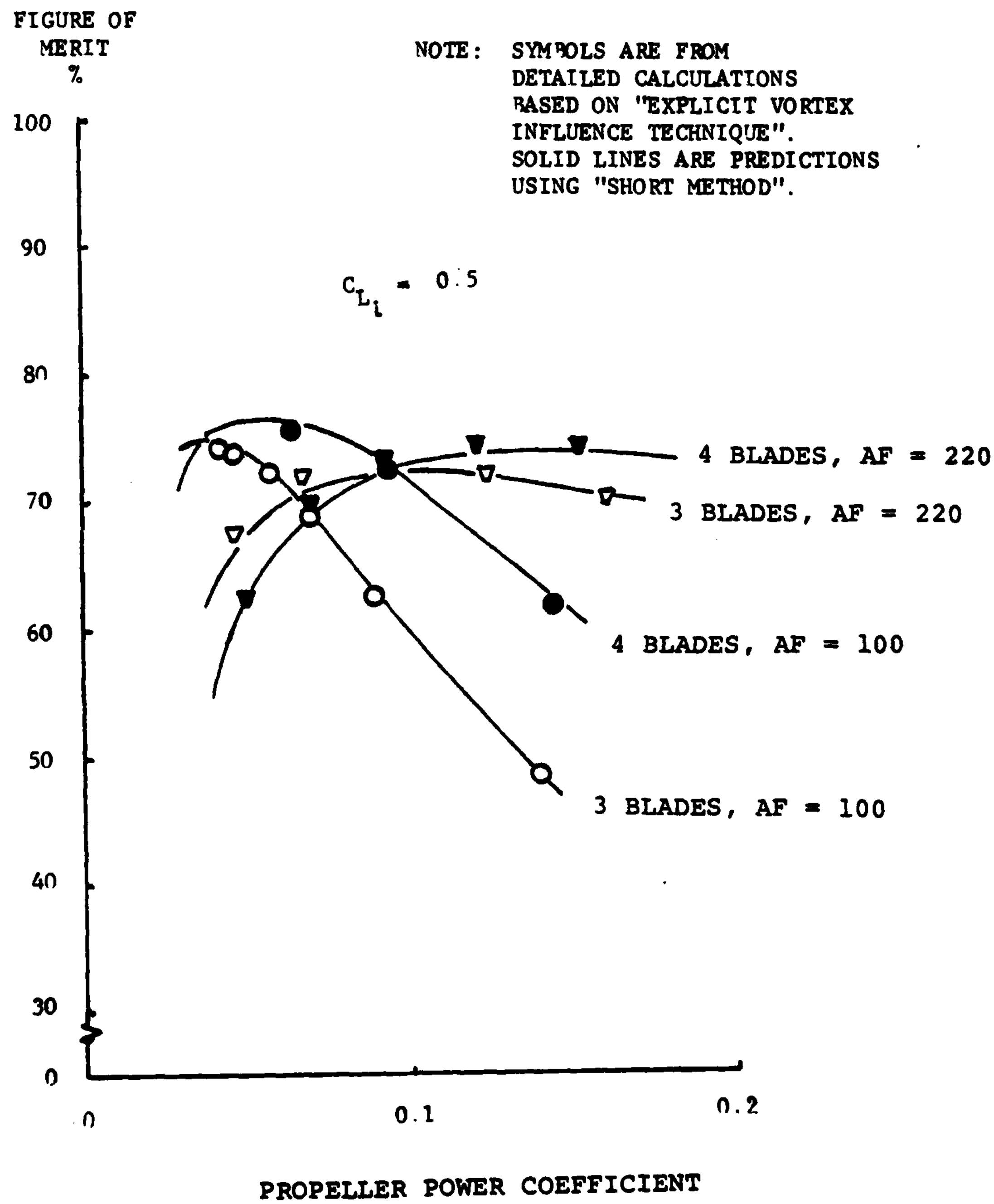


Figure 4-22a. Comparison of "Short Method" and Detailed Calculation for Propeller Hover Efficiency.

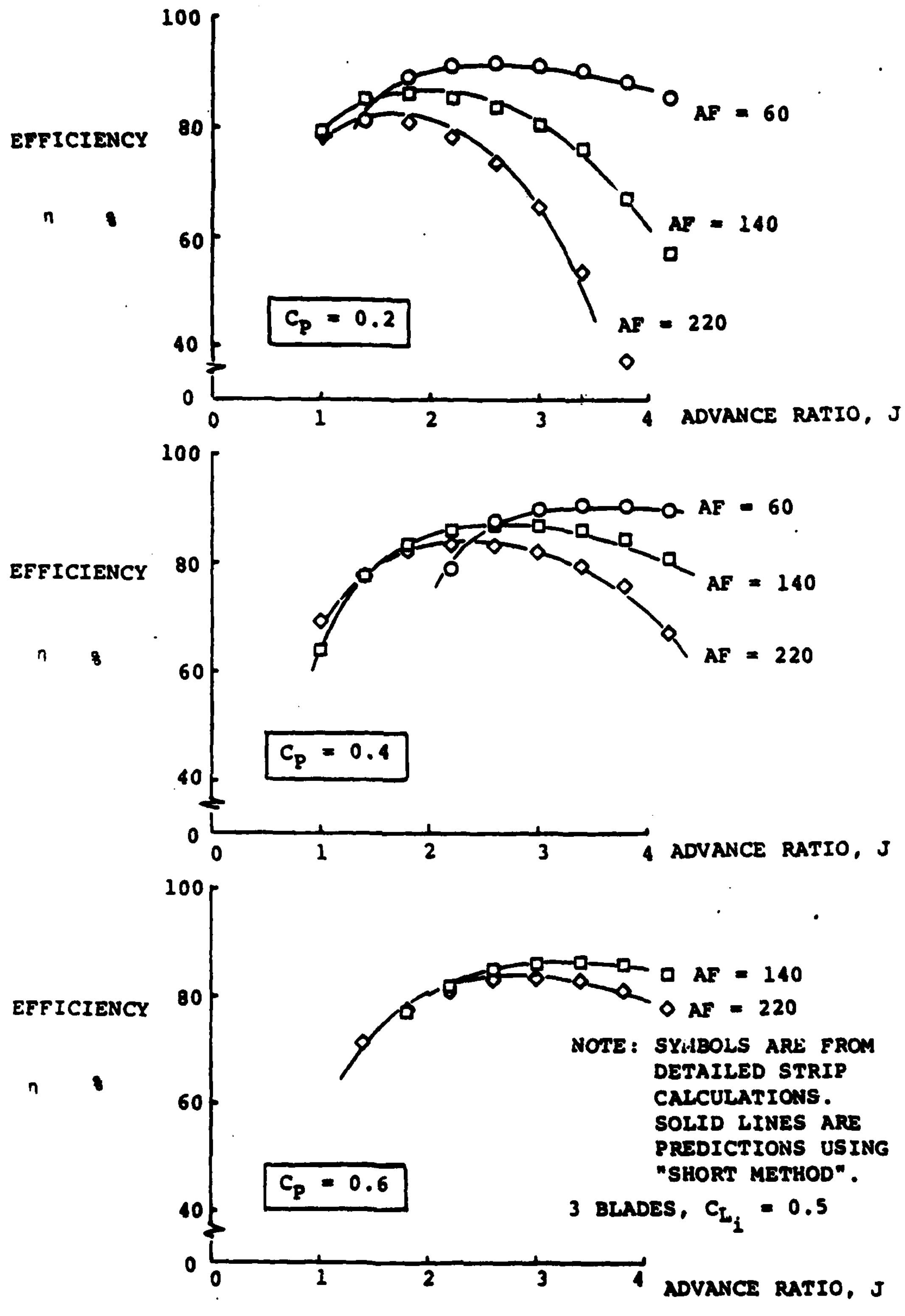


Figure 4-22b. Comparison of "Short Method" and Detailed Calculations for Propeller Cruise Efficiency.

This option will calculate the propeller performance for all mission performance segments except Descent (SGTIND = 5). For Descent, the user inputs a value for η_{P5}. Figure 4-23 is a flow chart of subroutine THRUST which calculates the propeller thrust available for known values of power and flight speed. Figures 4-24 and 4-25 are flow charts for subroutines POWER and POWERI in which the power required for specified thrust and flight speed is calculated. These subroutines make use of propeller equivalent lift-drag polars, as mentioned above, to calculate the performance of the propeller. The polars are developed in the main control loop for the particular value of integrated lift coefficient, C_{L_i}, being studied from the following equations:

$$\gamma = \tan^{-1} (C_D/C_L) = \text{function of } M_H,\ C_L,\ C_{L_i}$$

M_H = helical Mach number @ 3/4 r/R

C_L = equivalent lift coefficient at which prop is operating

C_{L_i} = integrated lift coefficient of prop

For Cruise

$$\gamma = a_o + a_1 C_{L_i} + a_2 C_{L_i}^{\ 2}$$

a_o, a_1, and a_2 are coefficients stored in the program and are functions of M_H and C_L .

The coefficients a_o, a_1, a_2, are listed in Table 4-3.

The calculations of propeller performance for η_pIND = 1 and 2 are based on the assumption that the engines are interconnected by a cross shaft. That is, if engines are shut down during cruise and loiter the remaining power is evenly distributed to all of the propellers.

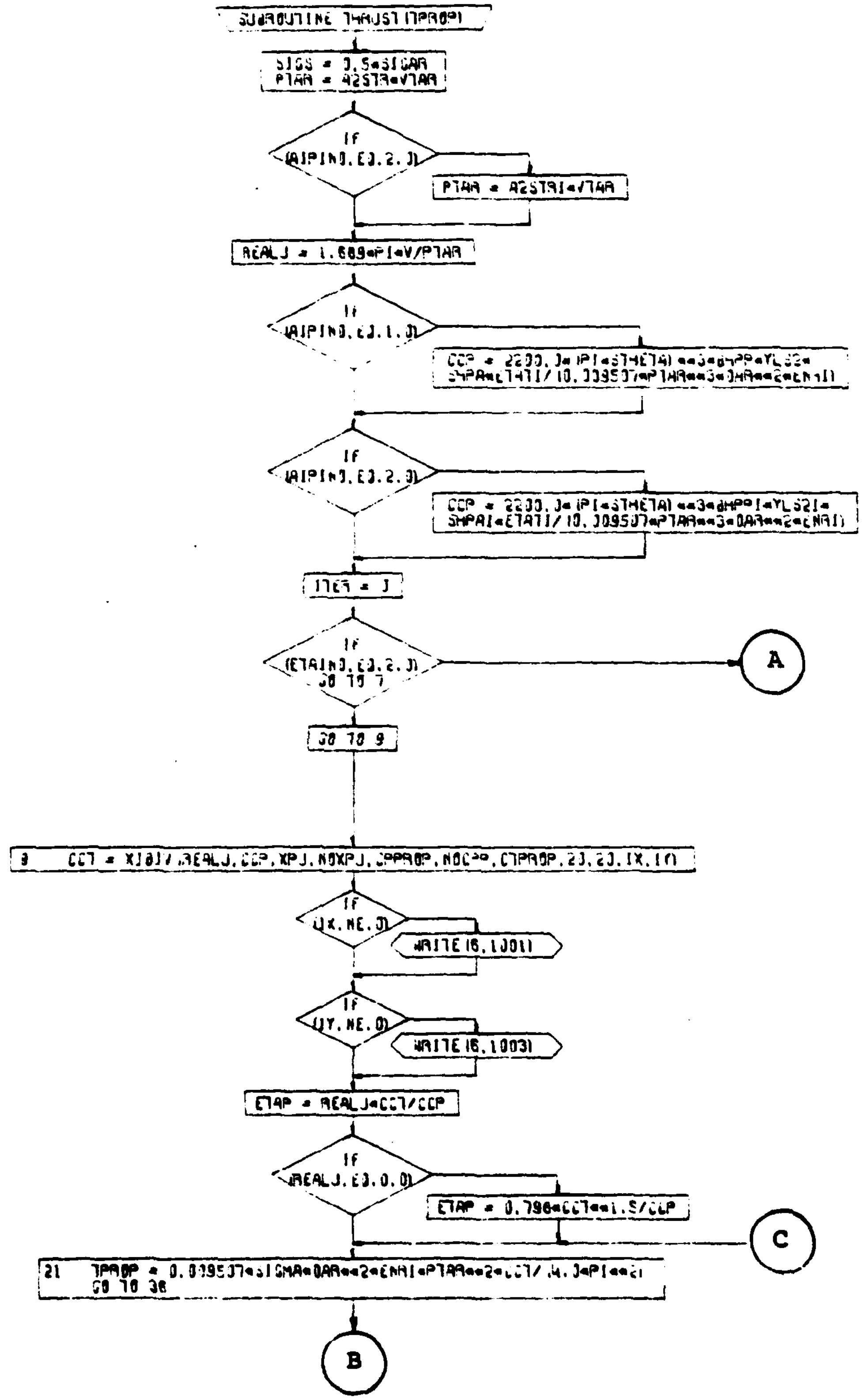


Figure 4-23. THRUST Subroutine Flow Chart (Part 1 of 4).

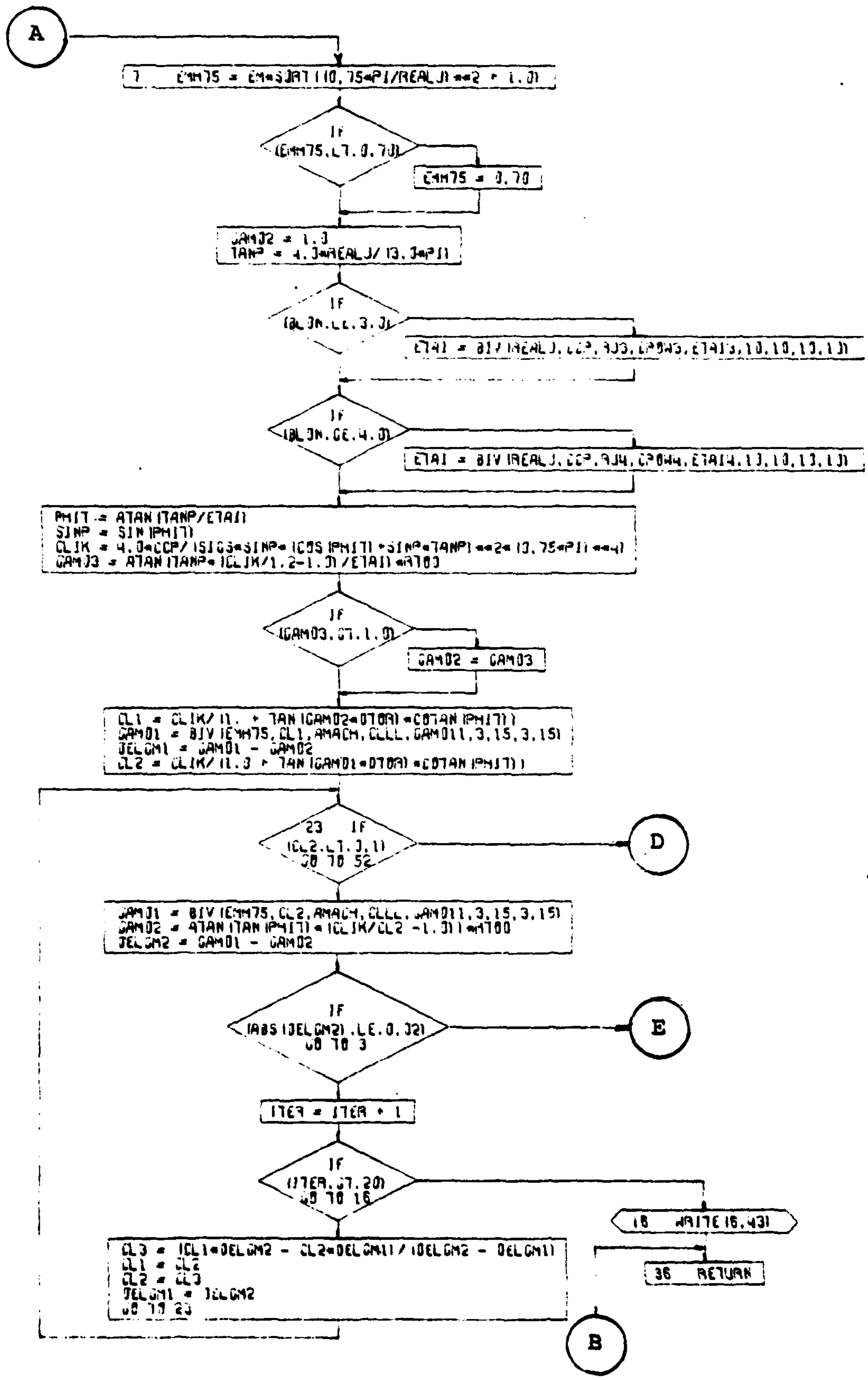


Figure 4-23. THRUST Subroutine Flow Chart (Part 2 of 4).

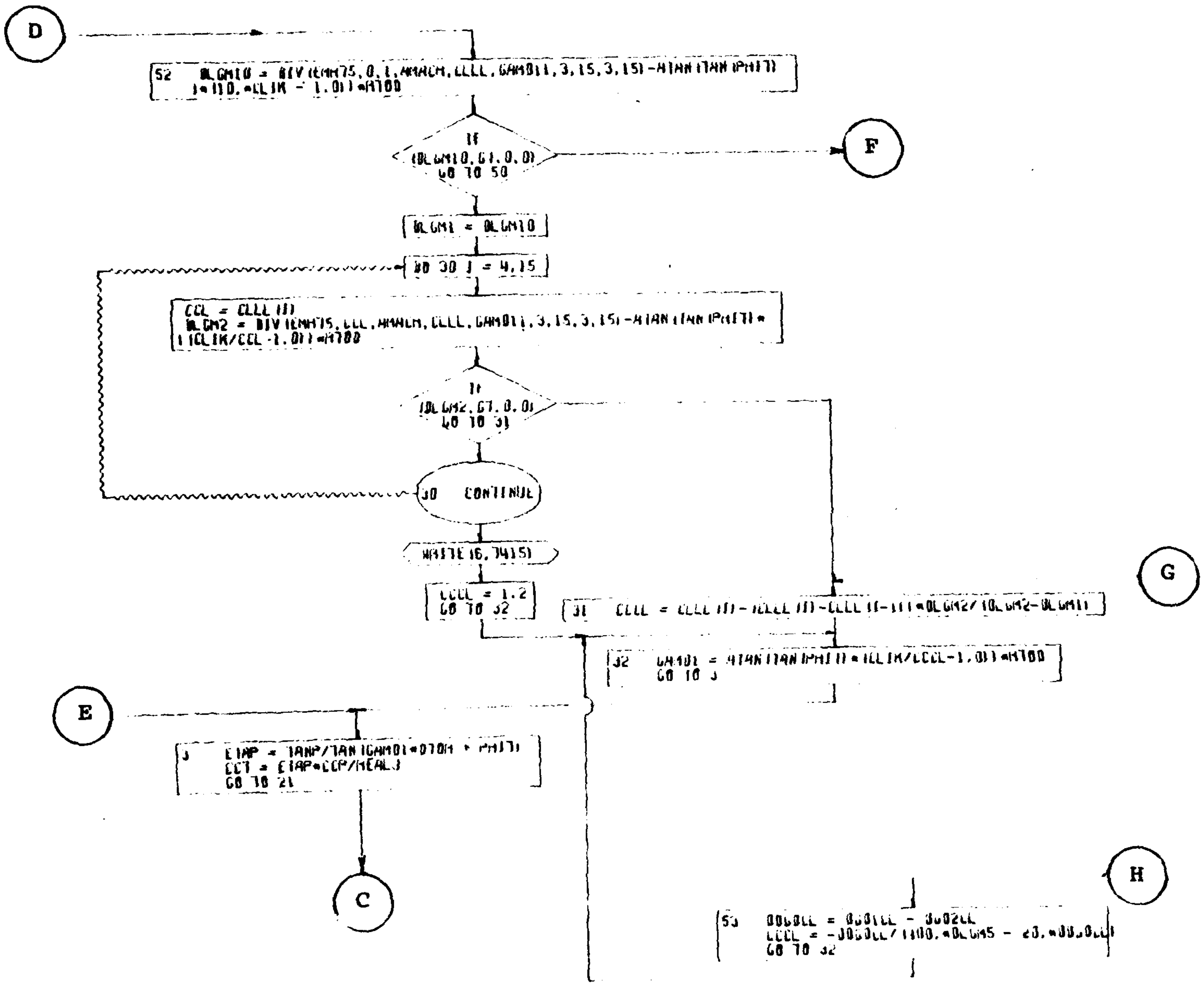


Figure 4-23. *THRUST* Subroutine Flow Chart (Part 3 of 4).

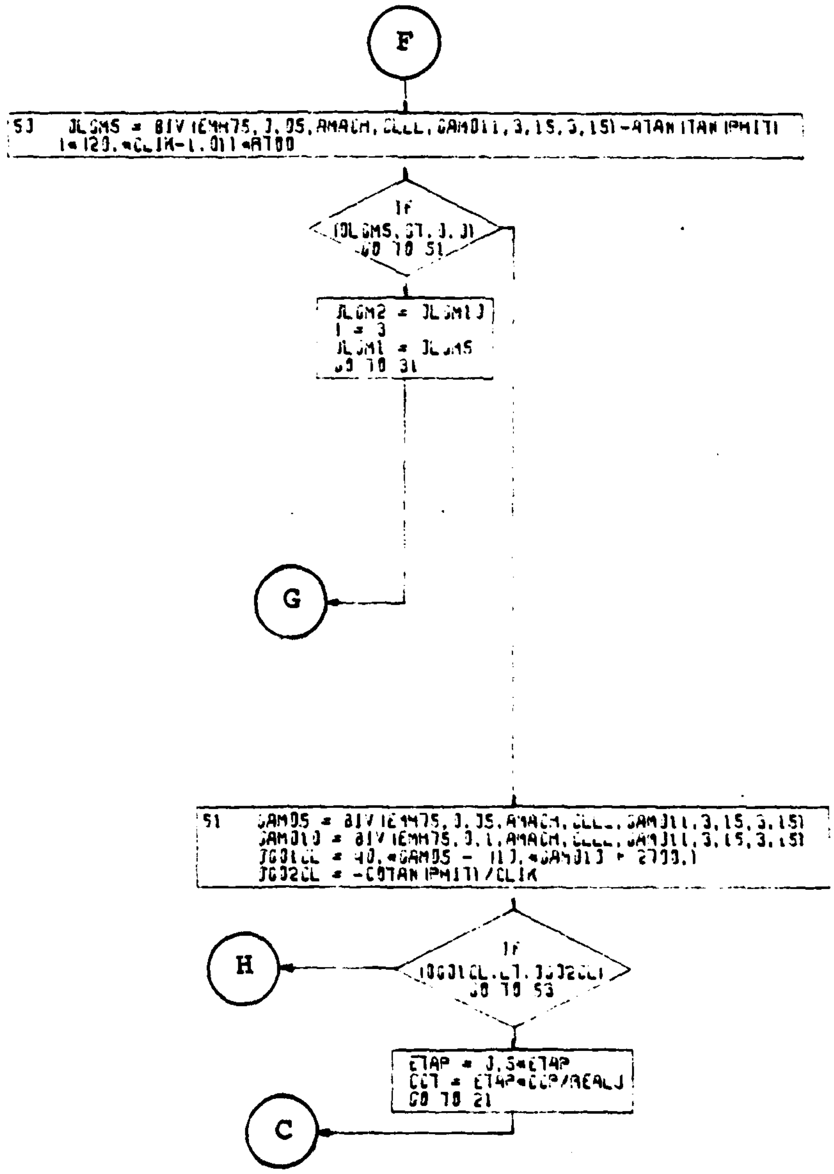


Figure 4-23. THRUST Subroutine Flow Chart (Part 4 of 4).

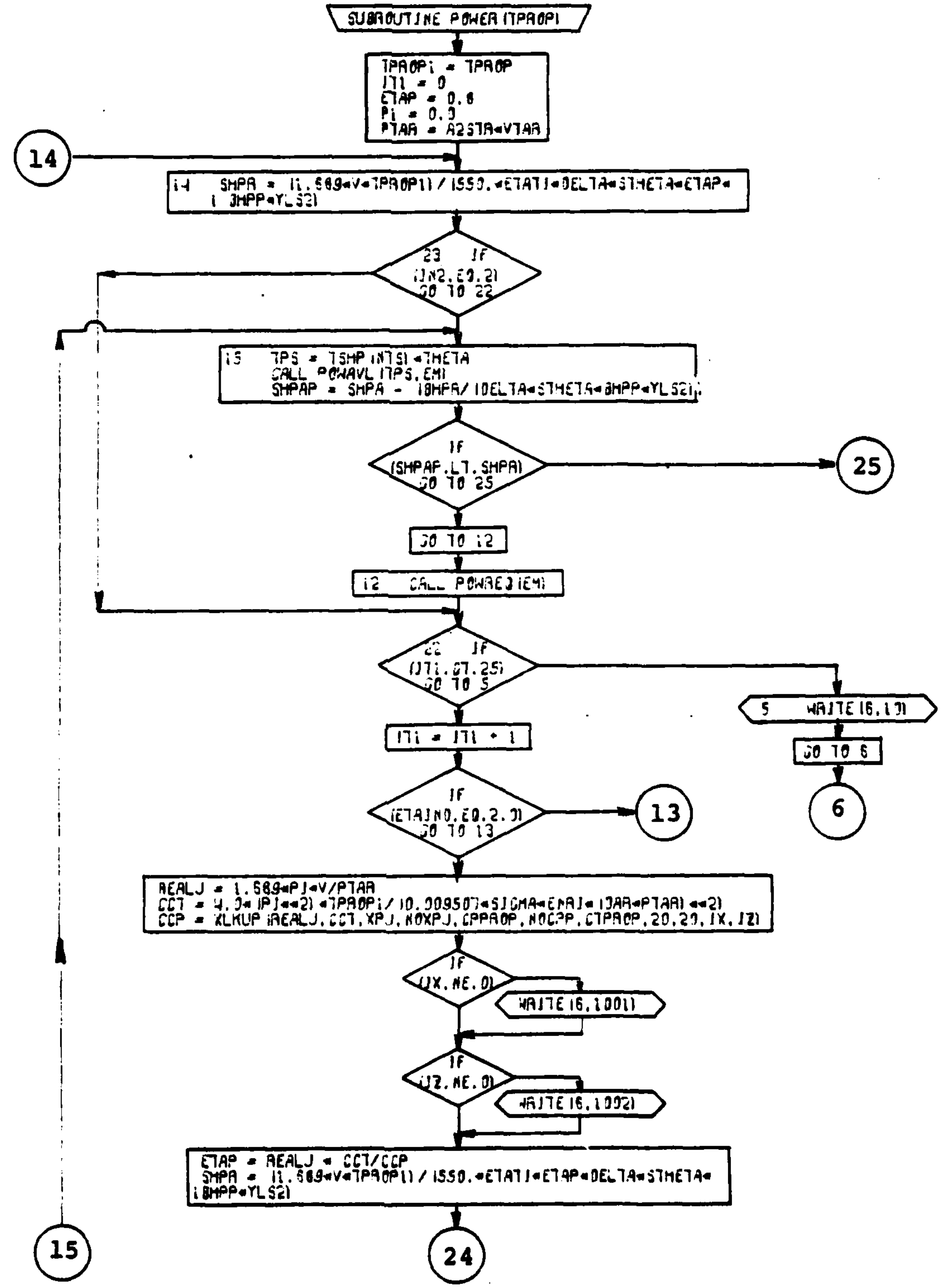


Figure 4-24. POWER Subroutine Flow Chart (Part 1 of 3).

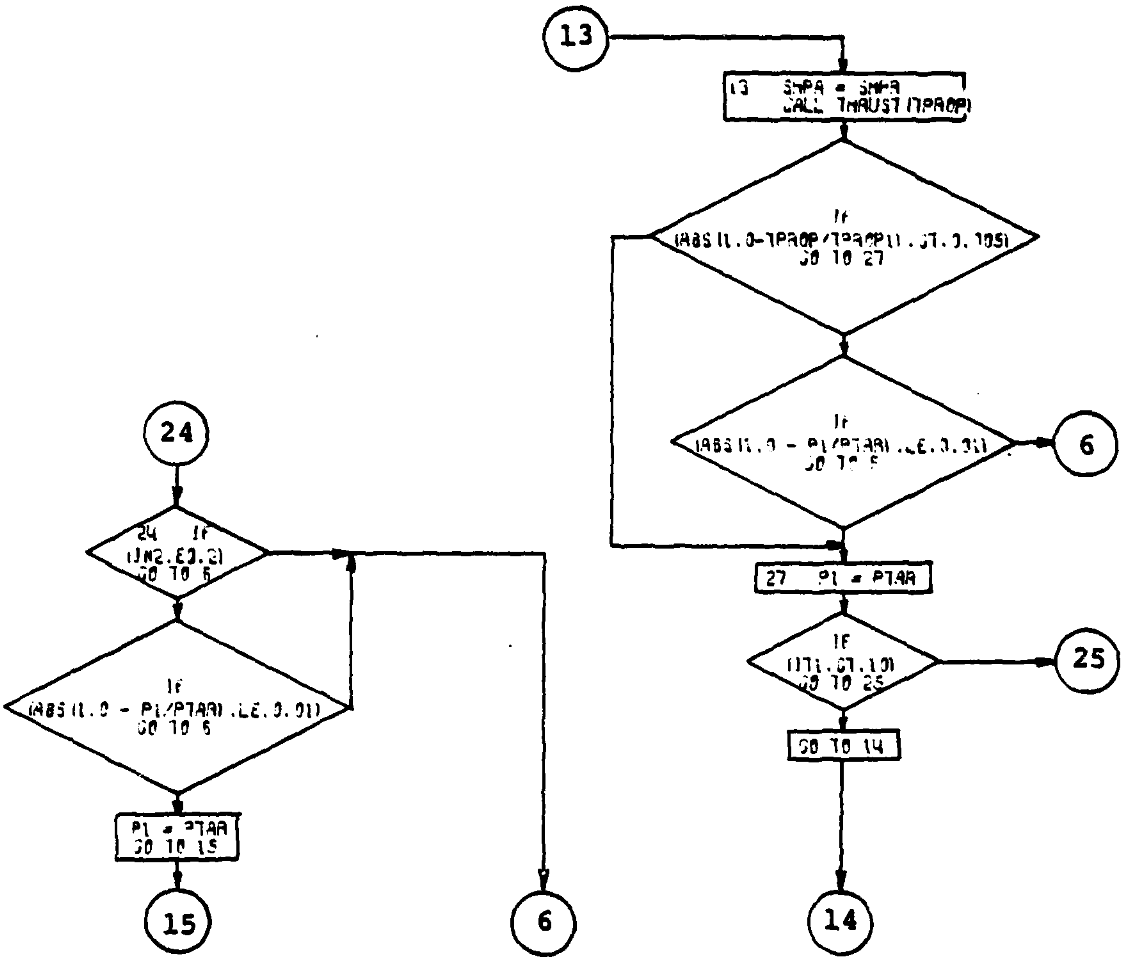


Figure 4-24. POWER Subroutine Flow Chart (Part 2 of 3).

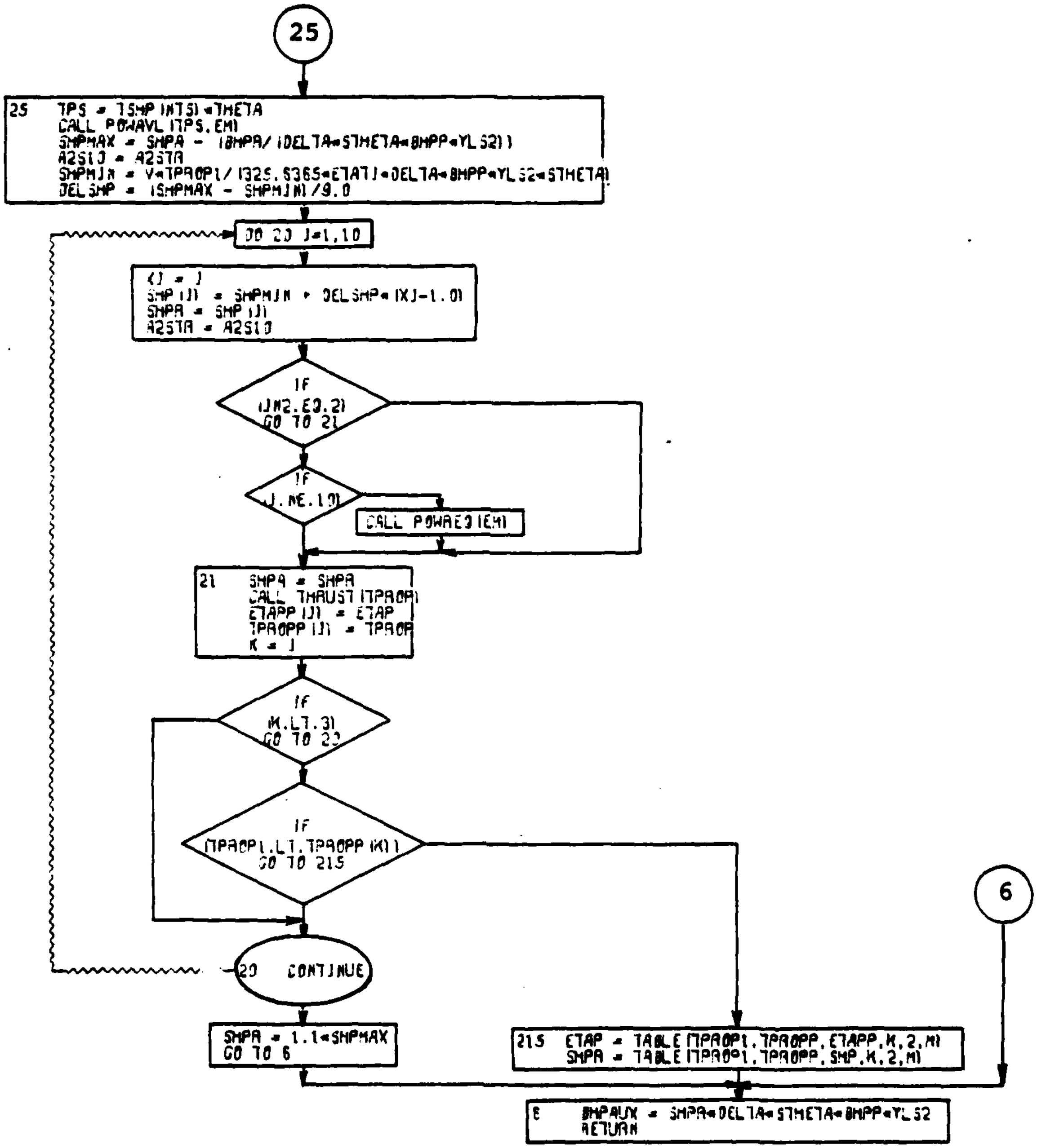


Figure 4-24. POWER Subroutine Flow Chart (Part 3 of 3).

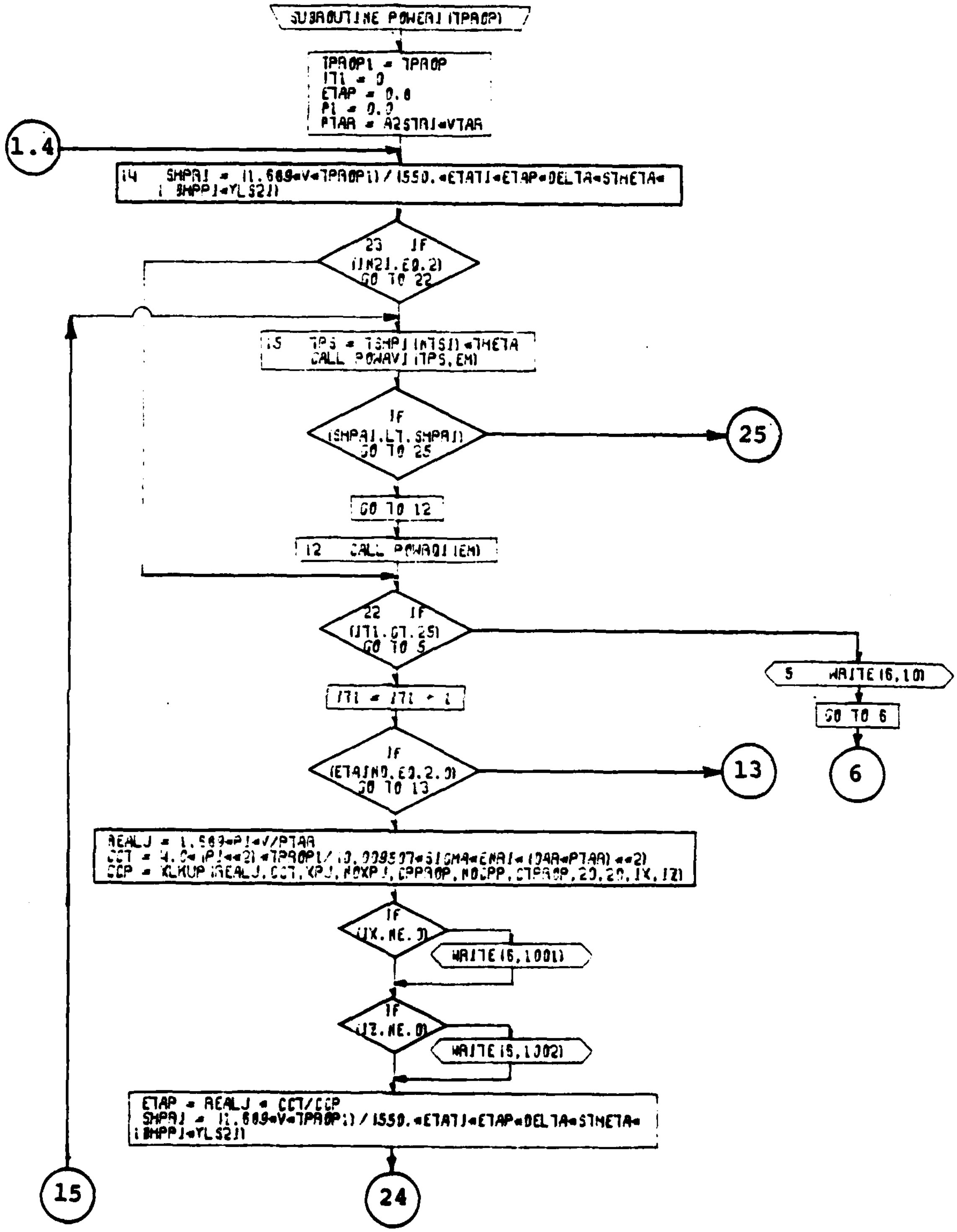


Figure 4-25. POWERI Subroutine Flow Chart (Part 1 of 3).

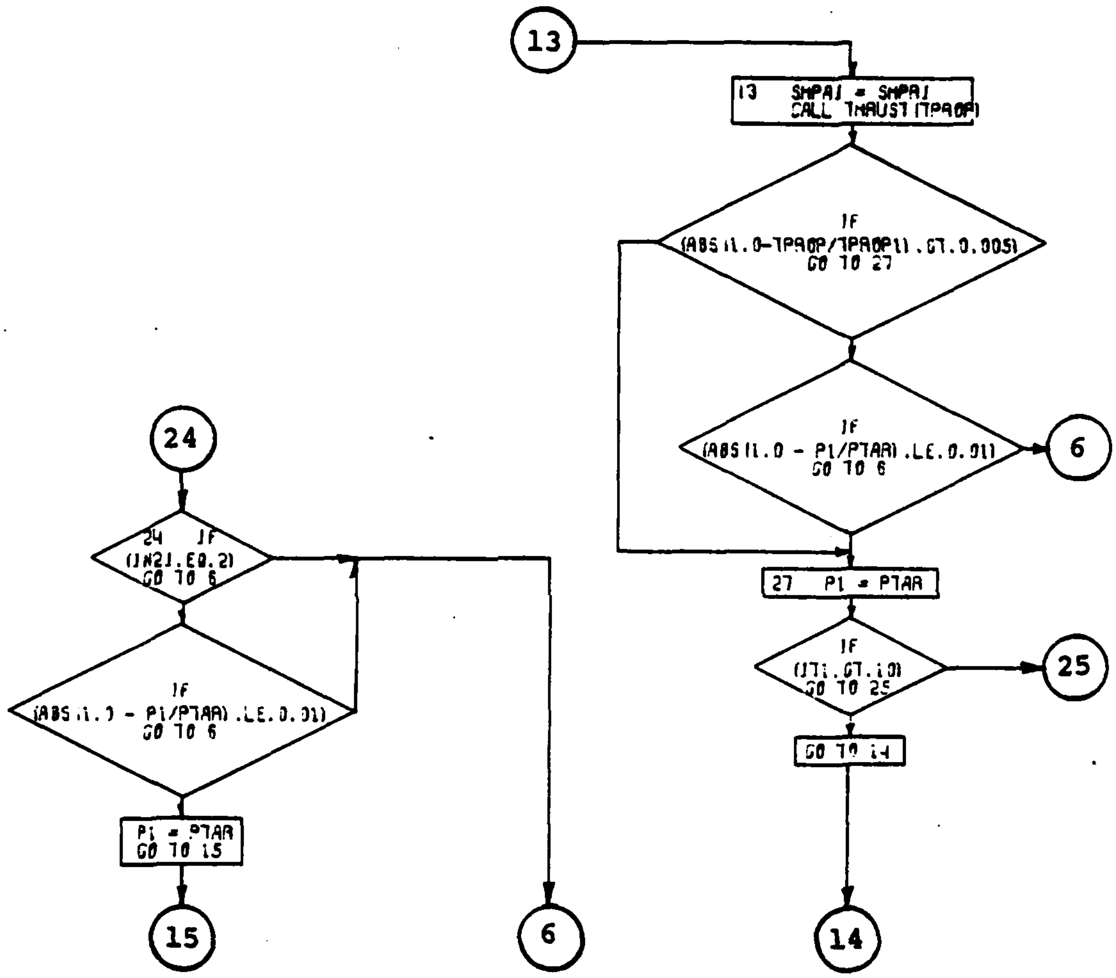


Figure 4-25. POWERI Subroutine Flow Chart (Part 2 of 3).

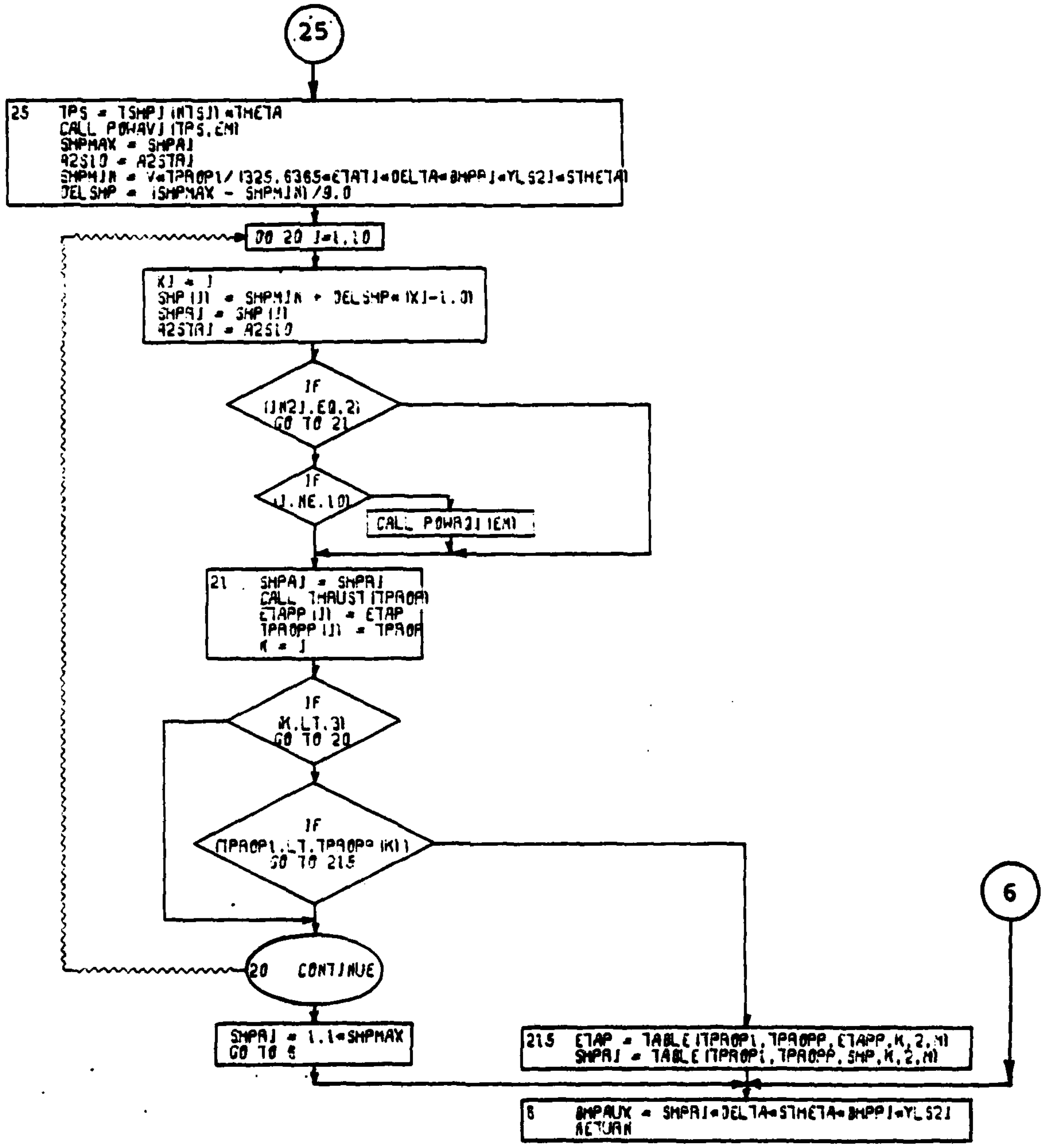


Figure 4-25. POWERI Subroutine Flow Chart (Part 3 of 3).

TABLE 4-3. COEFFICIENTS FOR PROPELLER EQUIVALENT POLARS

COEFFICIENTS FOR CRUISE:

C_L	M_H	a_0	a_1	a_2	M_H	a_0	a_1	a_2	M_H	a_0	a_1	a_2
0	0.7	90.	0.	0.	0.8	90.	0	0	0.9	90.	0.	0.
.05		7.0392	1.9949	61.2416		10.2148	2.4433	86.4731		11.3227	40.9515	21.9481
.10		4.8350	-4.1639	19.2195		8.3106	-22.6338	56.0		11.3355	-14.062	62.0142
.15		3.2218	-1.7030	8.291		5.4623	-14.9997	35.3636		8.3676	-12.2425	36.0889
.20		2.7551	-2.5322	7.0366		4.0458	-9.9837	23.0606		6.5856	-9.574	25.9573
.3		2.481	-4.5422	7.3774		3.9439	-13.0524	22.0028		5.3862	-8.9808	18.6439
.4		2.4521	-5.4949	7.4251		3.6769	-11.7146	17.3803		5.2054	-9.3153	16.4063
.5		2.8149	-7.092	8.3401		3.8766	-12.0044	16.0882		6.1902	-14.7567	23.2672
.6		3.8725	-10.861	11.4678		4.5901	-13.8756	17.2451		8.153	-25.0375	39.117
.7		5.6653	-16.2691	15.8093		6.1044	-18.2607	21.8349		10.1745	-30.7342	51.0509
.8		8.5799	-24.8115	22.6773		8.9031	-26.0958	30.7056		13.0822	-33.2211	58.1494
.9		12.25	-33.6185	28.7271		12.2042	-29.4588	34.1515		16.5344	-34.9378	64.3529
1.0		17.0496	-43.061	33.8798		17.0398	-37.3809	43.697		20.8089	-40.6314	76.3927
1.1		21.8332	-47.8821	33.6322		22.784	-47.3791	55.5455		25.6453	49.145	94.4326
1.2		31.7062	-49.6246	26.4923		28.7851	-57.8217	68.2121		33.5049	7.6449	144.4176

4.8 SIZE TRENDS SUBROUTINE

The size trends subroutine calculates the trends of the aircraft geometric dimensions as the weight of the aircraft changes throughout the iterative sizing loop. Figure 4-29 displays a flow chart showing the options available within the size trends subroutine.

The first of these is the option which determines main rotor diameter and solidity. It is possible to input diameter and solidity directly, or combinations of disc loading, design C_T/σ, diameter, and solidity. The following choices, specified by the main rotor sizing indicator, RDMIND, are available:

RDMIND	INPUT
1	Diameter and solidity
2	Disc loading and solidity
3	Diameter and C_T/σ
4	Disc loading and C_T/σ

If main rotor solidity is calculated, the program will choose the solidity satisfying the most critical of the three groups of requirements specified by input locations 0182 - 0190. These *solidity sizing requirements are:*

(a) Soliditv sized for hover conditions (Input $(C_T/\sigma)_H$, T/W)

(b) Solidity sized for maneuver conditions (Input cruise speed, atmospheric conditions, maneuver C_T/σ, and rotor g loading)

(c) Solidity sized for cruise conditions (Input cruise speed, atmospheric conditions, cruise C_T/σ, and rotor loading (N))

If so desired, the user may dictate which of these solidity choices the program makes simply by manipulating the inputs. For example:

If the solidity sizing choice desired is:	Then input:
Hover	Desired value for $(C_T/\sigma)_H$, $(C_T/\sigma)_{CR}$ = 1.0, g_{ROTOR} = .001, N(Rotor Loading) = 0.1

Maneuver	$(C_T/\sigma)_H$ = 1.0, Desired values for $(C_T/\sigma)_{CR}$ and g_{ROTOR}, N(Rotor Loading) ≈ 0.1
Cruise	$(C_T/\sigma)_H$ = 1.0, Desired value of $(C_T/\sigma)_{CR}$, G_{ROTOR} = 0.001, Desired value of N(Rotor Loading)

As noted earlier, two basic types, the single and tandem rotor helicopter, can be sized using this program. The following (beginning with the single rotor helicopter) provides a brief description of the options available to the user.

Tail rotor diameter may be input directly, or calculated. The choices open to the user are:

<u>TRDIND</u>

0	No tail rotor used on this configuration
1	Tail rotor diameter calculated using a trend
2	Tail rotor diameter input directly
3	Tail rotor diameter calculated based on an input tail rotor disc loading

TRDIND = 0 signifies a single rotor helicopter without a tail rotor (e.g., a coaxial rotor, or a single rotor configuration employing main rotor torque cancellation by means other than a tail rotor or fan).

The tail rotor diameter trend used when TRDIND = 1 is illustrated in Figure 4-26 (see also Reference 6). The tail rotor disc loading input when TRDIND = 3 does not include vertical fin sideload losses.

Tail rotor solidity may be input directly or calculated. If calculated (TRDIND = 2), the tail rotor solidity is determined by either hover-antitorque requirements or hovering-turn requirements (including tail rotor precession effects, see References 5 and 6). The former is obtained by setting $\dot{\psi}$ (yaw rate) and $\ddot{\psi}$ (yaw acceleration) equal to zero.

Yaw moment inertia (I_{ZZ}) is required in calculating the tail rotor solidity for the single rotor helicopter in a hovering turn. The following equation is included in the size trends subroutine to determine the aircraft yaw inertia.

$$I_{ZZ} = \frac{W}{32.2} (0.115 K_{ZZZ}\ e)^2$$

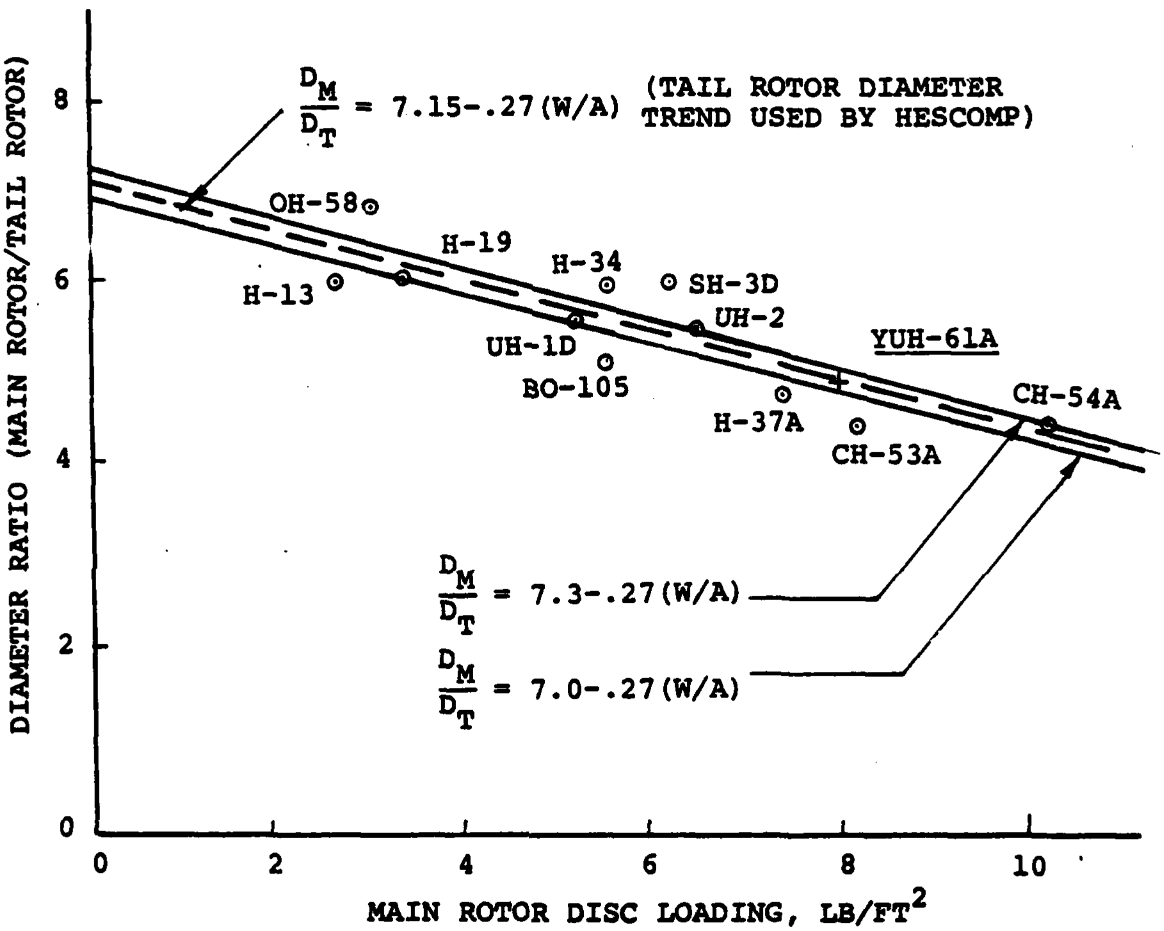


Figure 4-26. Tail Rotor Diameter Sizing Trend.

Where I_{ZZ} = Yaw moment of inertia, slug ft^2

W = Aircraft design gross weight, lb

K_{ZZZ} = Inertia adjusting factor (nominally = 1.0)

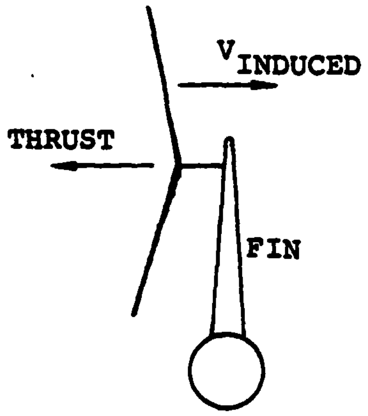
e = The combined sum of the study aircraft fuselage length and the cabin length measured from the nose of the aircraft to the end of the cabin.

0.115 = Trend constant for determining the single rotor helicopter yaw moments of inertia.

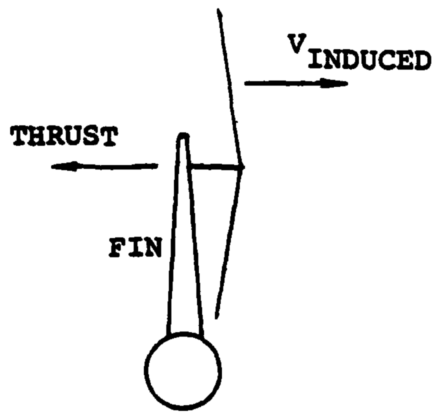
To modify the equation inertia value, enter a fractional input in the K_{ZZZ} block (LOC 0213) (entering 1.1 will increase the 0.115 constant by 10 percent, entering 0.9 will decrease it by 10 percent, etc.)

K_{TRS} (LOC 0215) is tail rotor solidity multiplicative factor.

It should be noted that the tail rotor gross/net thrust ratio ($C_{T_G}/C_{T_{NET}}$) may either be input directly or calculated. In the latter instance, $C_{T_G}/C_{T_{NET}}$ is set equal to 1.00 and a value of the induced velocity ratio ($\bar{C}$) is input. Figure 4-27 illustrates typical values of $\bar{C}$ for both tractor and pusher tail rotor (see sketch below).



Tractor Tail Rotor



Pusher Tail Rotor

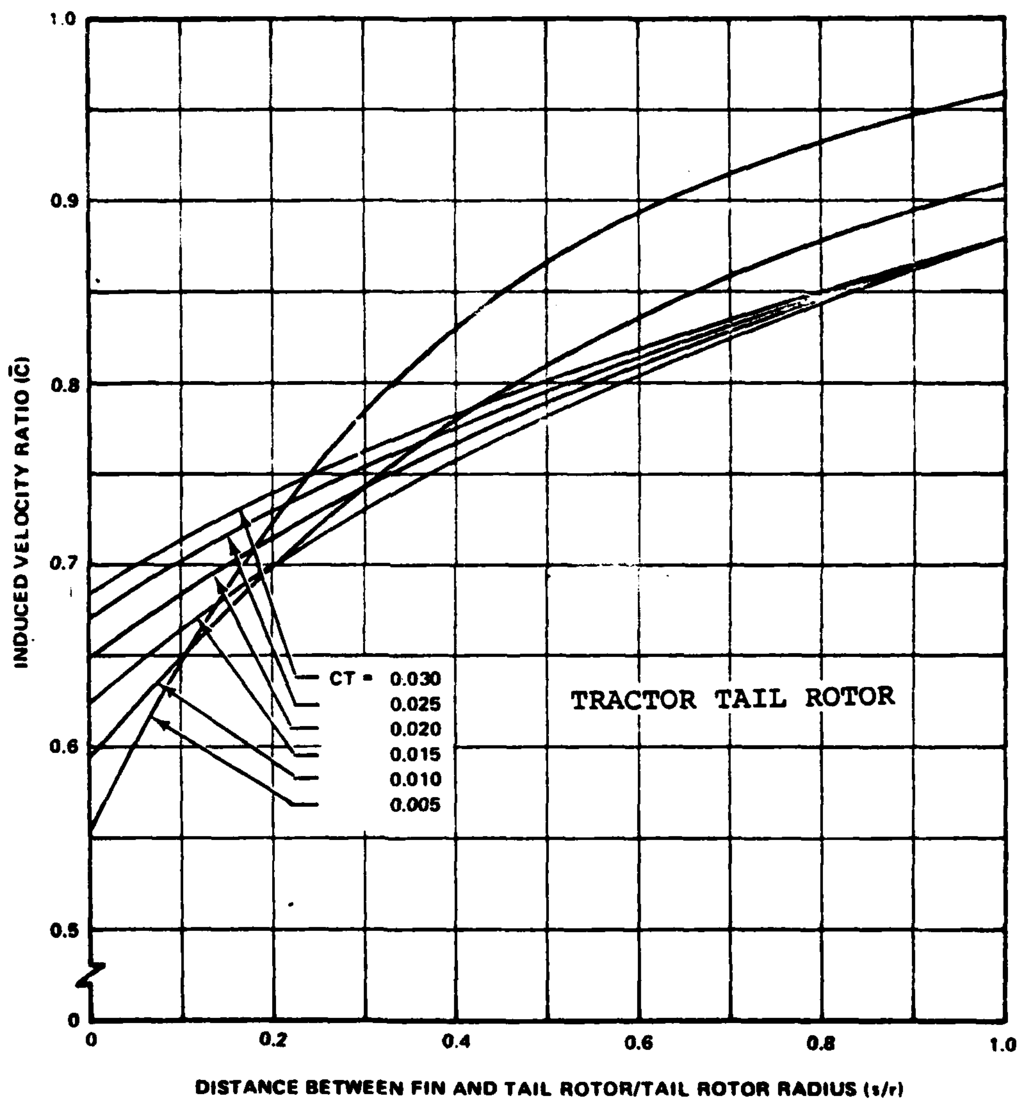


Figure 4-27. Tail Rotor/Vertical Tail Fin Interference Data (Part 1 of 2).

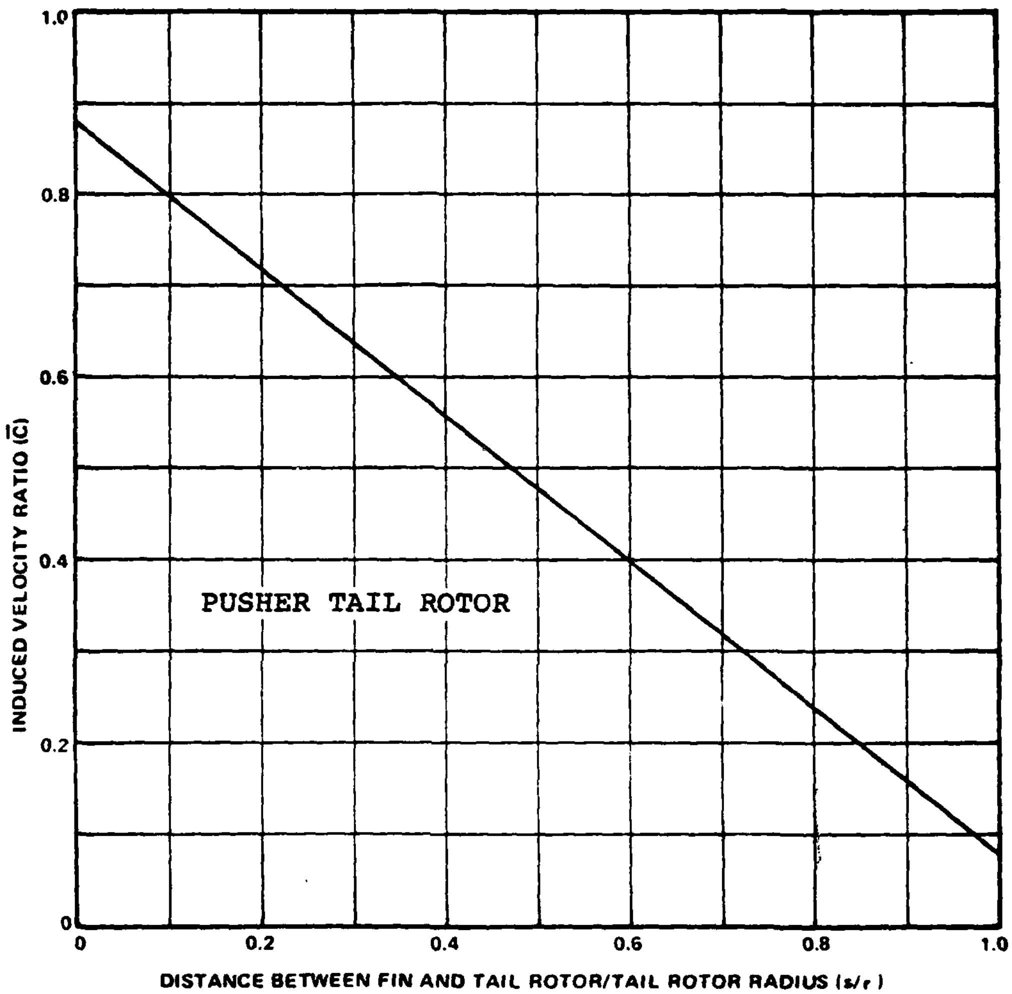


Figure 4-27. Tail Rotor/(Pusher Tail Rotor) Vertical Tail Fin Interference Data (Part 2 of 2).

Note the difference in variations of $\overline{C}$ for the two different configurations. At low tail fin/rotor separation distances, the "tractor" values of $\overline{C}$ are sensitive to variations in tail rotor C_T. Thus, the closer the tractor tail rotor is located to the fin, the larger the error (admittedly small to begin with) involved in calculating C_{T_G}/C_{T_N}, since the user must "guess" what tail rotor C_T to use in selecting $\overline{C}$. The "pusher" $\overline{C}$ on the other hand is a function only of the fin/tail rotor separation distance.

In any event, use of this option is desirable in that tail rotor/fin sideload losses are matched to the vertical tail area calculated in the sizing process. Detailed explanations of all the factors involved in tail rotor design and sizing are contained in References 5 and 6.

Representation of a single rotor helicopter utilizing a "Fenestron" or shrouded tail rotor/fan is provided by the use of inputs D_{TRE}/D_{FAN} (LOC 0282), $FANOP_H$ (LOC 0283), and $FANOP_C$ (LOC 0284).

Such shrouded tail rotor/fans can provide the same thrust as a larger diameter unshrouded rotor for a given power input. This is achieved by "sharing" the total tail rotor thrust requirement between the rotor and the shroud, the fractional split (T_{SHROUD}/T_{TOTAL}) depending on such factors as shroud length/fan diameter, duct inlet lip shape, etc. The ratio of the equivalent diameter unshrouded rotor to the shrouded rotor/fan diameter can be related to the rotor/shroud thrust split by the following relationship:

$$D_{TRE}/D_{FAN} = \sqrt{\frac{1}{1 - \frac{T_{SHROUD}}{T_{TOTAL}}}}$$

Typical values of T_{SHROUD}/T_{TOTAL} range from .3 to .5 (resulting in values of D_{TRE}/D_{FAN} = 1.2 - 1.4).

Setting $FANOP_H$ or $FANOP_C$ equal to 1.0, allows representation of tail rotor/fan shutdown in hover and cruise flight respectively.

The vertical tail size may be determined in three ways. If VTFIND = 1, aspect ratio and tail fin/tail rotor overlap is input. If VTFIND = 2, tail fin/tail rotor overlap and configuration directional stability requirements are input. If VTFIND = 3, the input is the same as with VTFIND = 2, with the exception that AR_{VT} is specified instead of tail rotor/fin overlap. These latter two options are important in that they allow the user to size the vertical tail to meet cruise anti-torque requirements at specified conditions ($C_{L_{Des}}$, V_{Des}) in the event of tail rotor loss. It should be noted that $C_{L_{Des}}$ is assumed to represent the total lift coefficient developed by a conventional tail fin in sideslip, or a tail fin with a variable camber device (i.e., a rudder or flap) deployable under these circumstances.

The horizontal tail size is an input and must be specified as planform area S_{HT} (option HTIND = 1) or tail volume $\bar{V}_H$ (option HTIND = 2) defined as follows:

$$\bar{V}_H = \frac{16 \ell_{TH} S_{HT}}{\pi 2 \; D_{MR}^3}$$

Where: ℓ_{TH} = distance from the main rotor hub to the aerodynamic center of the horizontal tail - ft

D_{MR} = main rotor diameter - ft

The horizontal tail is designed to achieve angle of attack as well as speed stability of the helicopter. The planform area required to achieve an acceptable longitudinal stability level is a function of the design gross weight, type of rotor system, tail rotor cant angle and tail moment arm as illustrated by the sizing trends for current helicopters presented in Figure 4-28. These trends represent a design criteria of approximately neutral static longitudinal stability at $\mu \geq .2$. As illustrated in this figure, aircraft with hingeless or articulated rotor systems require larger tail areas than aircraft with teetering rotors due to the larger destabilizing hub moment associated with locating the flapping hinge outboard of the center or rotation. The largest tail size is required for configurations employing canted tail rotors because of their large aft c.g. range.

For preliminary design studies, the sizing trends shown in Figure 4-28 can be used to define the inputs S_{HT} or $\bar{V}_H$; however an estimate of design gross weight and moment arm is required. As noted in Table 4-4, the ratio ℓ_{TH}/R_{MR} for current helicopters is on the order of 1.0 to 1.2. The main rotor radius (R_{MR}) can be defined from gross weight and disk loading estimates.

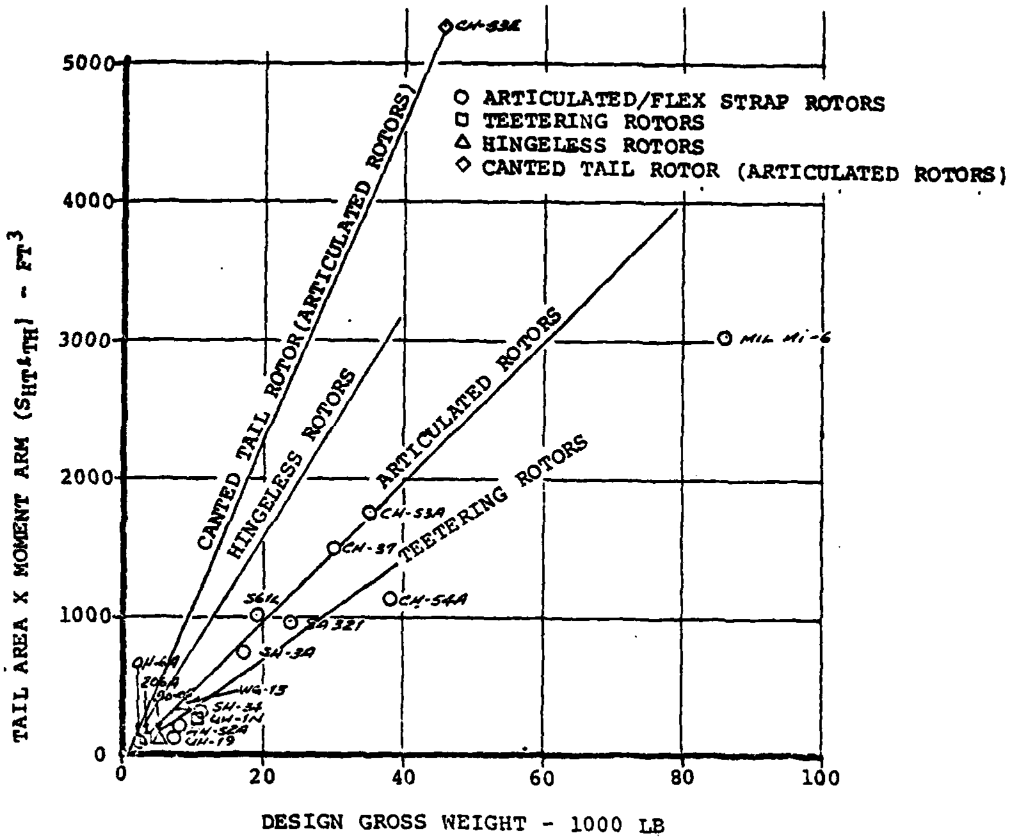


Figure 4-28. Horizontal Tail Sizing.

TABLE 4-4. PRODUCTION HELICOPTER HORIZONTAL TAIL PARAMETERS.

TYPE OF ROTOR	AIRCRAFT	DESIGN GROSS WEIGHT-LB	MAIN ROTOR DIAMETER-FT	TAIL AREA - FT^2	ℓ_{TH}/R_{MR}
ARTICULATED & FLEXSTRAP	OH-6A	2200	26.3	6.7	1.09
	UH-19	7200	53	4.5	1.09
	HH-52A	7900	53	7.2	1.17
	SH-34	11000	56	10.7	1.01
	SH-3A	17000	62	20	1.21
	S-61L	19000	62	27	1.21
	SA321	24000	62	25.5	1.23
	CH-37	30000	72	34.2	1.22
	CH-53A	35000	72	40	1.22
	CH-54A	38000	72	26	1.22
	MIL Mi-6	86000	114.8	53	1.0
HINGELESS	BO-105	5070	32.2	8.6	.93
	WG-13	9500	42	12	1.23
ARTICULATED WITH CANTED TAIL ROTOR	CH-53E	46000	79	121	1.10
TEETERING	206A	3000	33.3	9.4	.75
	UH-IN	10500	48	23.5	.70

For detailed design studies, further analyses of aircraft longitudinal stability is required prior to finalizing the tail design. This is particularly true for winged and compound helicopters where wing and auxiliary propulsion effects must be considered.

Forward rotor pylon dimensions are specified directly (input LOCS 0152 - 0156).

The computer program calculates the length and wetted area of the fuselage based upon input values of cabin length, cabin mean diameter, fineness ratios of the pilots section and tail section, and calculated tail boom dimensions. The tail boom length is established by the tail rotor diameter, the need to maintain a reasonable gap between the main and tail rotor discs and the relative position of the main rotor on the fuselage. This position (Xm/ℓ_B - LOC 0128) may either be input (MRPIND = 0) or calculated (MRPIND = 1, 2), using a simple weight-balance subroutine. If MRPIND = 1, the program calculates main rotor positions based on simple mass balance. The relative positions (from the aircraft nose) of the various aircraft components (engines, primary drive system, etc.), must be input (LOCS 2678-2696). If MRPIND = 2, the program calculates main rotor positions based on simple mass balance as in MRPIND = 1, except for the case of a compound helicopter, the auxiliary drive system, propeller and auxiliary independent engines are assumed to be located on the wing. Additional increments of fuselage wetted area (to account for miscellaneous bulges, fairings, etc.) may be input through the use of $\Delta S_{wet}/S_F$ (LOC 0120) and ΔS_{wet} (LOC 0121).

A single rotor helicopter without a tail rotor (e.g., a coaxial rotor) may be sized by setting TRDIND = 0. In this case, fuselage dimensions are input as before, with the exception of the tail boom. Tail boom length is determined by the relative position of the main rotor on the fuselage and the horizontal distance between the tip of the tail boom and the main rotor disc. This distance is input in the location (LOC 0214) used for specifying the main/tail rotor disc gap for conventional single rotor helicopters. Note that this dimension can be either positive or negative, the latter defining a configuration where the empennage carried by the tail boom lies under the main rotor disc. In addition, VTFIND (LOC 0017) must be input as 1, vertical tail area being calculated from input values of AR_{VT} (LOC 0135) and vertical tail span (when TRDIND = 0, vertical tail span (in feet) is input in LOC 0139 (K_Z)).

Three options are available for sizing a tandem rotor helicopter fuselage. These options, specified by the indicator FDMIND, are:

FDMIND	Input	Calculated
1	((O/L)/D), forward, aft rotor positions	fuselage length (ℓ_F)
2	((O/L)/D), cabin length (ℓ_C)	fuselage length (ℓ_F) forward & aft rotor positions
3	cabin length (ℓ_C), forward and aft rotor positions	((O/L)/D), fuselage length (ℓ_F)

In cases (FDMIND = 1) where the calculated cabin length is less than zero, an error statement is printed and the case terminated. Likewise, if the rotor overlap/diameter ratio exceeds either +0.5 or -0.5, the case is terminated.

The aft rotor pylon dimensions may either be input directly (APHIND = 1) or calculated (APHIND = 2) based on an input of rotor gap/stagger ratio. The forward pylon dimensions are input directly as in the case of the single rotor helicopter.

In the case of a compound helicopter, propeller dimensions and characteristics (i.e., AF, blade number, C_{L_i}, etc.) are input directly.

Wing sizing options are divided into two groups, those for determining wing area (S_WIND) and those for determining wing span (b_WIND). Wing area may either be input directly (S_WIND = 1), calculated based on an input wing loading (S_WIND = 2), or sized to meet a maneuver requirement. In the latter case, the wing size is dictated by the need to carry the difference between the overall g requirement (LOC 0188) and the maneuver g's (LOC 0189) carried by the main rotor(s). Wing span may be determined on the basis of an input wing span/rotor diameter ratio (b_WIND = 1), an input aspect ratio (bWIND = 2); or, in the case of a compound helicopter with wing mounted propellers, on the basis of propeller tip/fuselage clearance considerations (b_WIND = 3).

The dimensions of the primary and auxiliary independent engine nacelles are determined by the horsepower or thrust level of the engines. Separate input constants z_1, z_2, z_3, z_4, z_5 and z_6 are used to calculate the size of the nacelles.

Primary engine nacelles

$$\text{Diameter (ft)} = z_1 \left[\frac{SHP^*}{N_P}\right]^{1/2}$$

$$\text{length (ft)} = z_2 + z_3 \left[\frac{SHP^*}{N_P}\right]^{1/2}$$

$$\text{wetted area (ft}^2\text{)} = N_P \, \pi (\text{dia})(\text{length})$$

Auxiliary independent engine nacelles

$$\text{diameter (ft)} = z_4 \left[\frac{SHP^*_i}{N_{P_i}}\right]^{1/2} \text{ or } z_4 \left[\frac{F_N^*}{N_{P_i}}\right]^{1/2}$$

$$\text{length (ft)} = z_5 + z_6 \left[\frac{SHP^*_i}{N_{P_i}}\right]^{1/2} \text{ or } z_5 + z_6 \left[\frac{F_N^*}{N_{P_i}}\right]^{1/2}$$

$$\text{wetted area (ft}^2\text{)} = N_{P_i} \, \pi \, (\text{dia})(\text{length})$$

Figure 4-29 shows a flow chart of this subroutine.

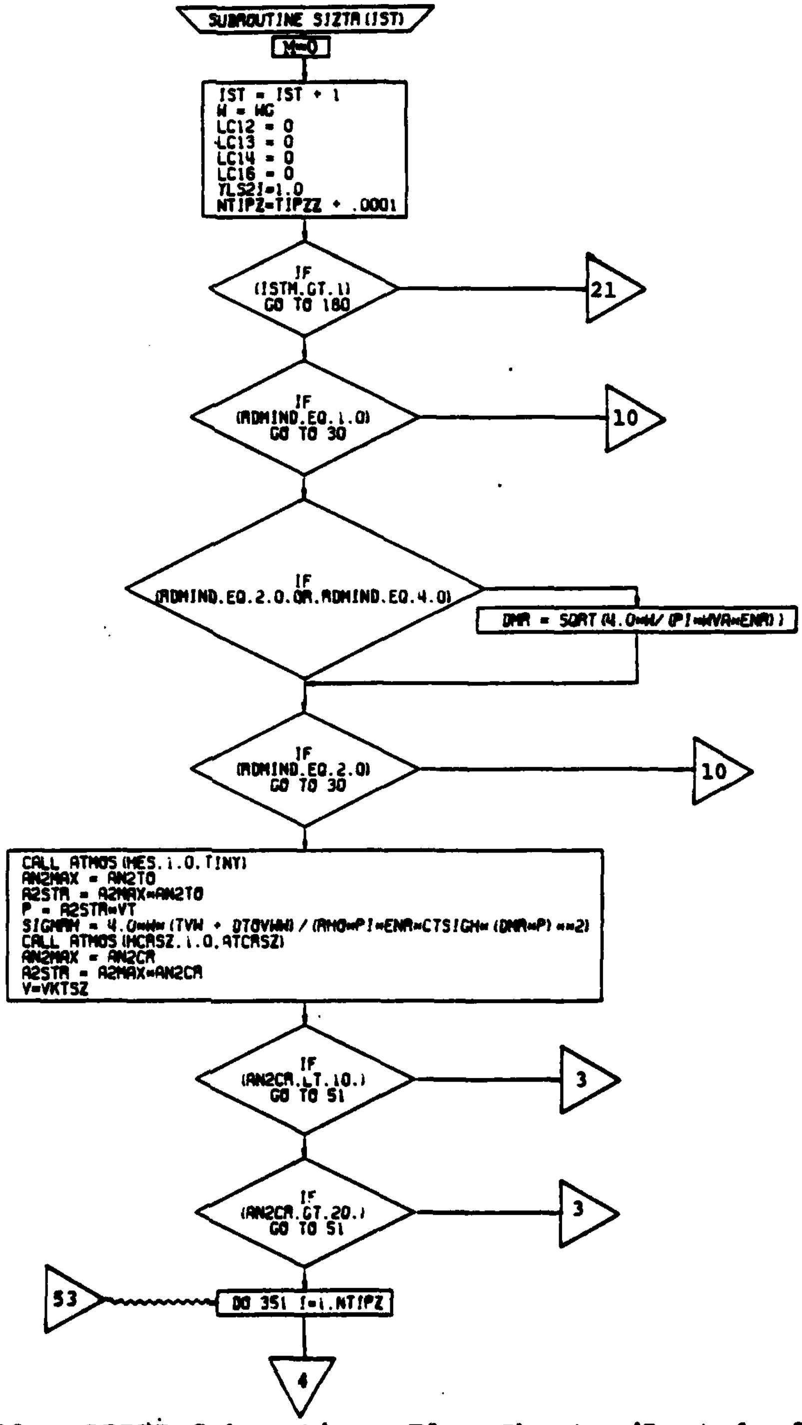


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 1 of 12)

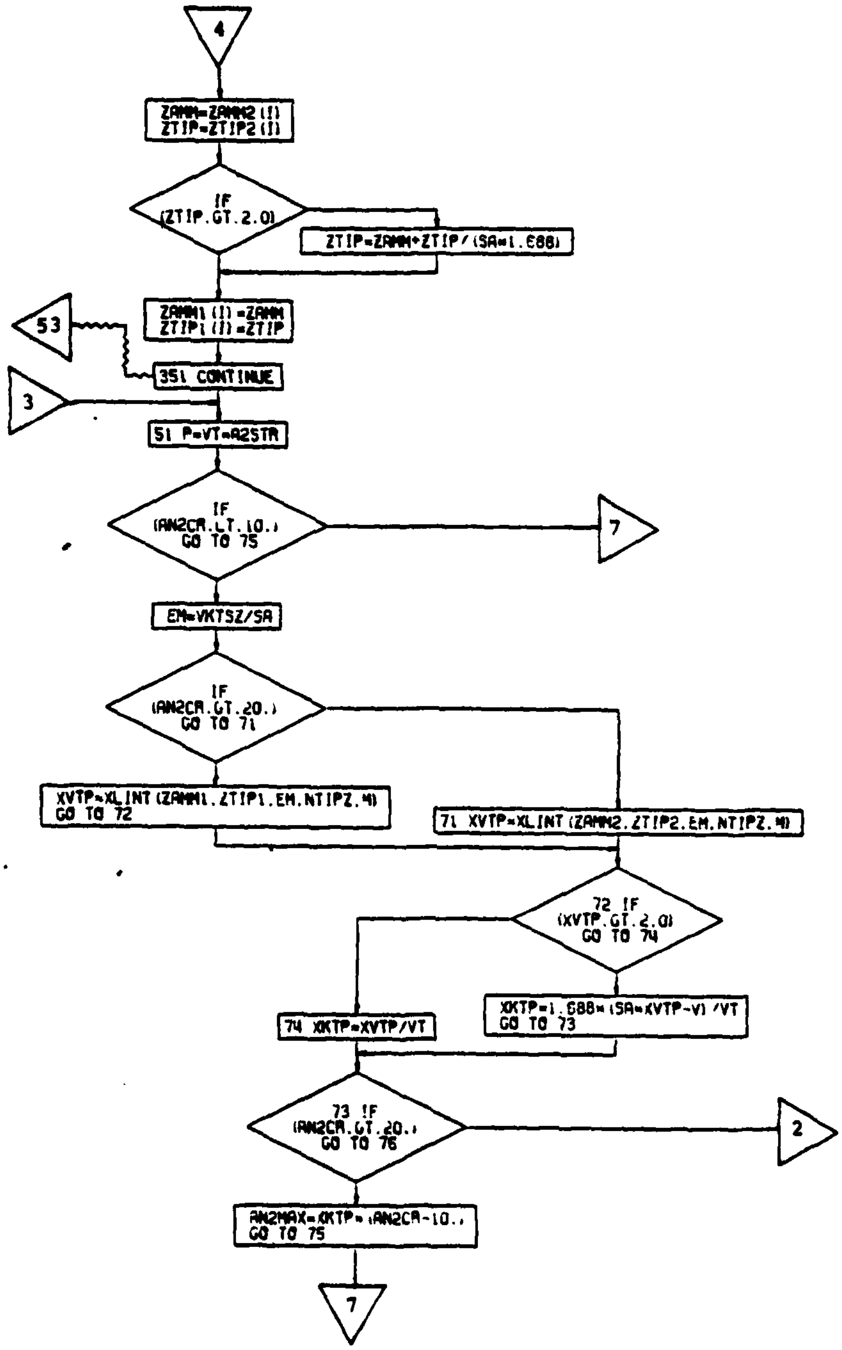


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 2 of 12)

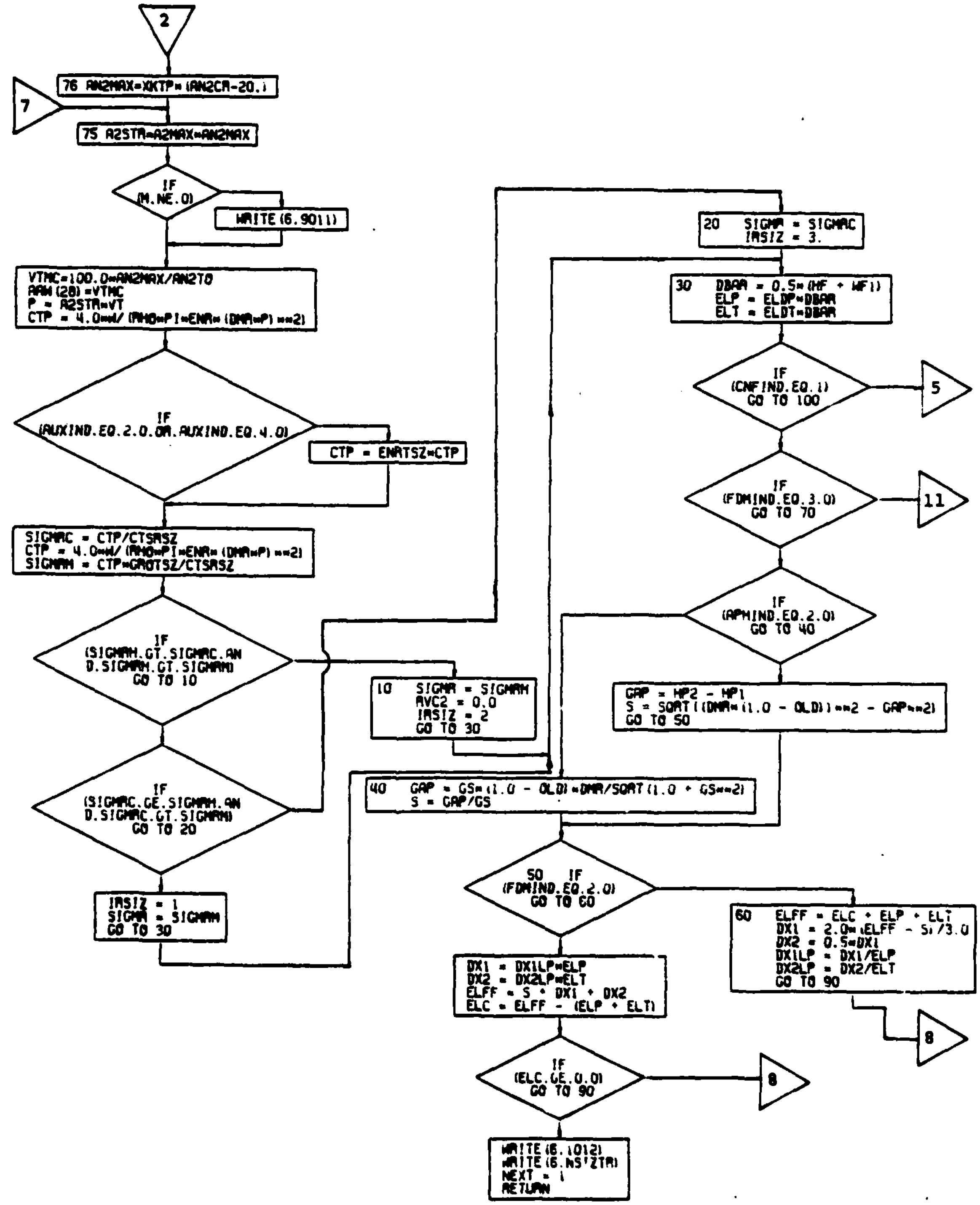


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 3 of 12)

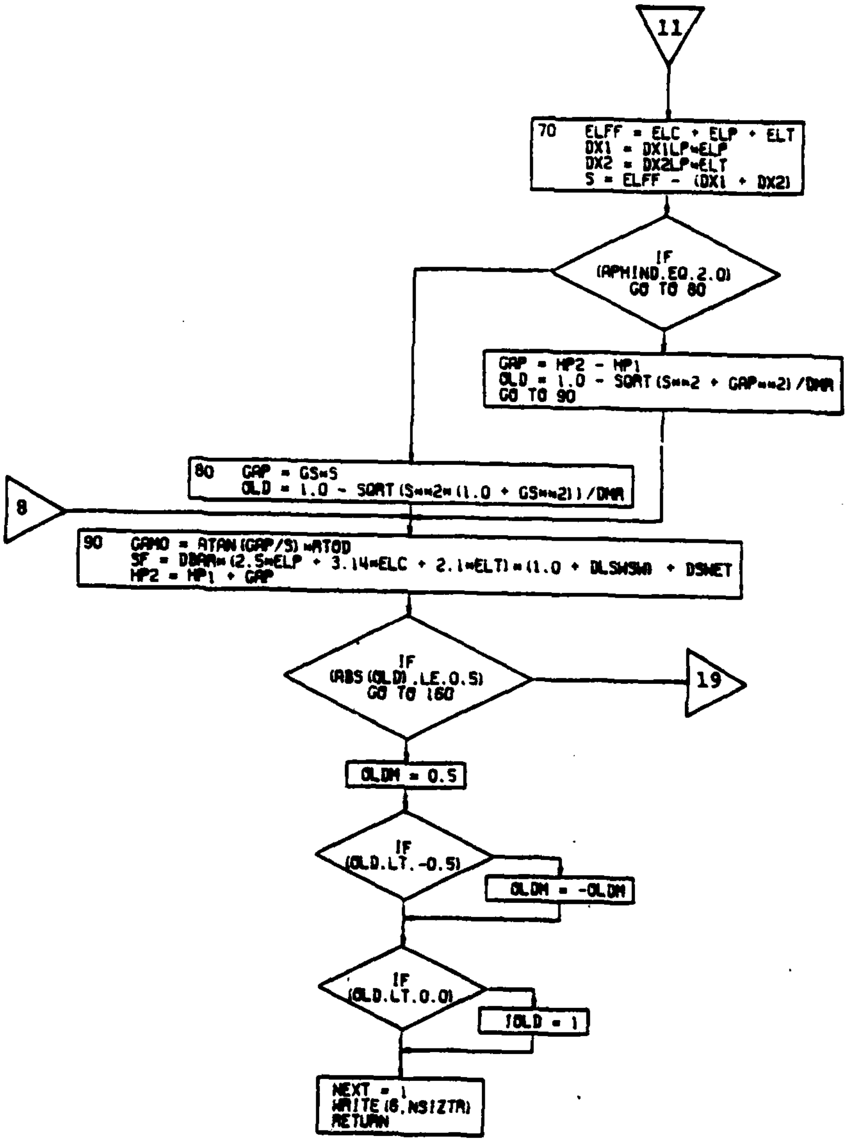


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 4 of 12)

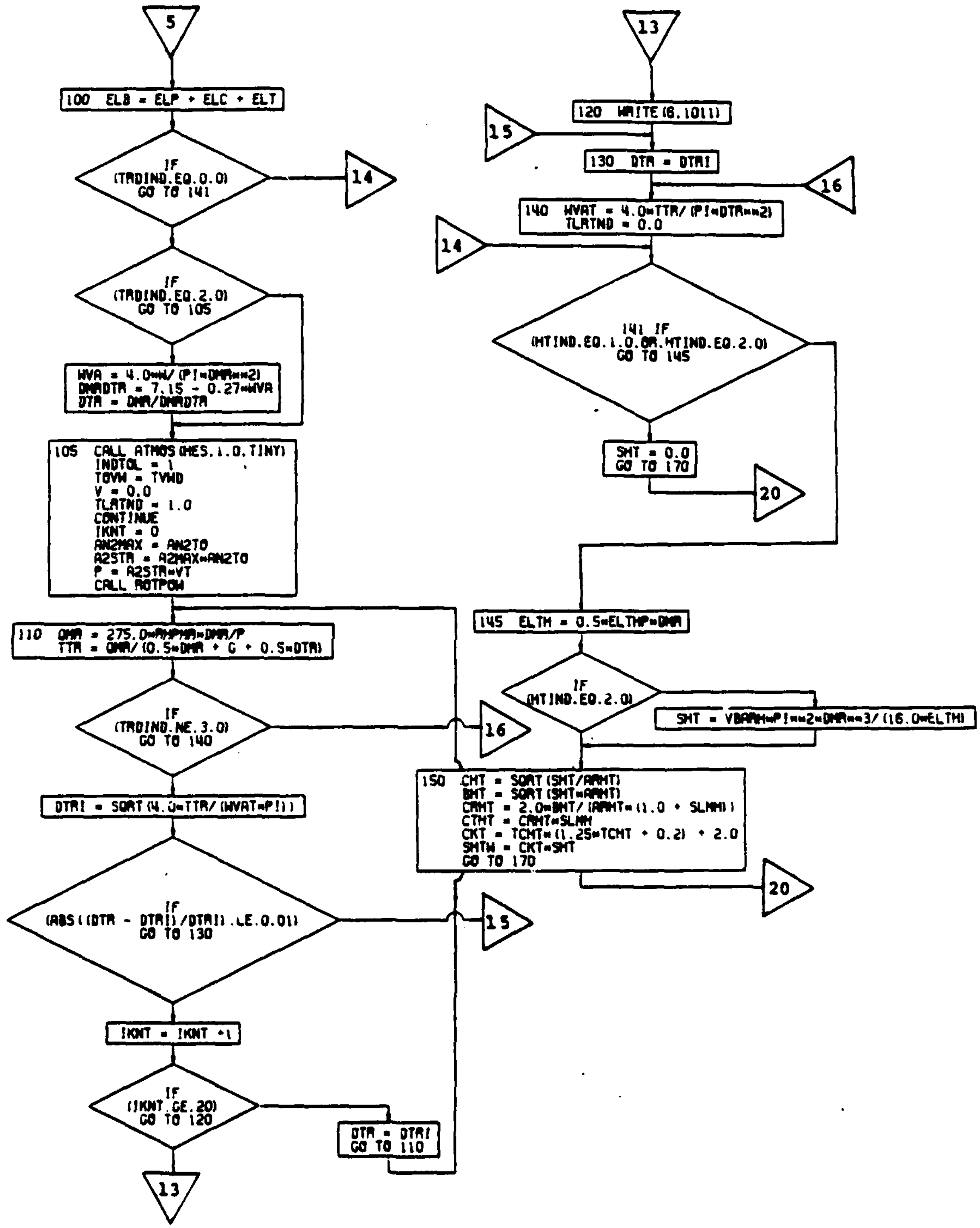


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 5 of 12)

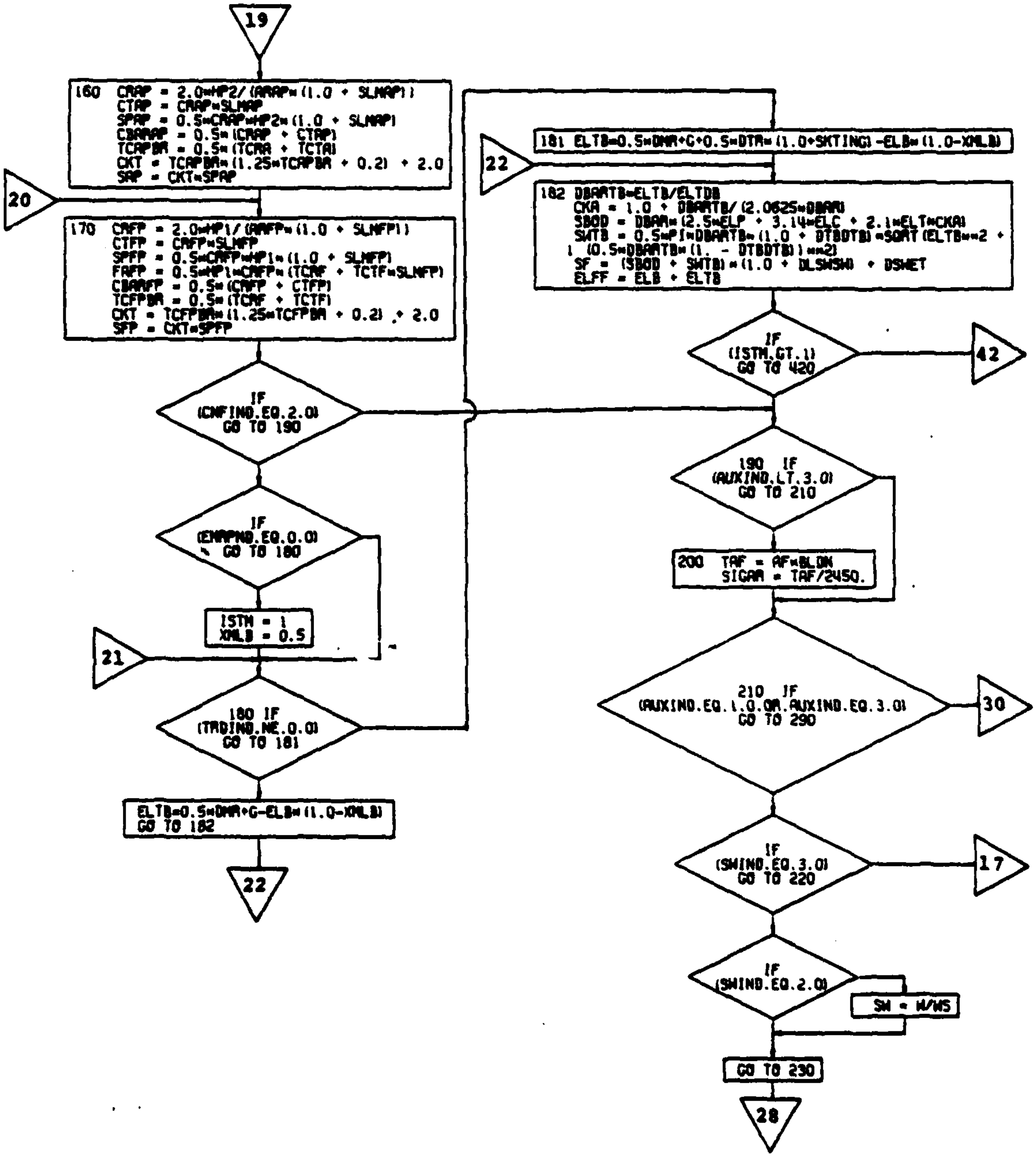


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 6 of 12)

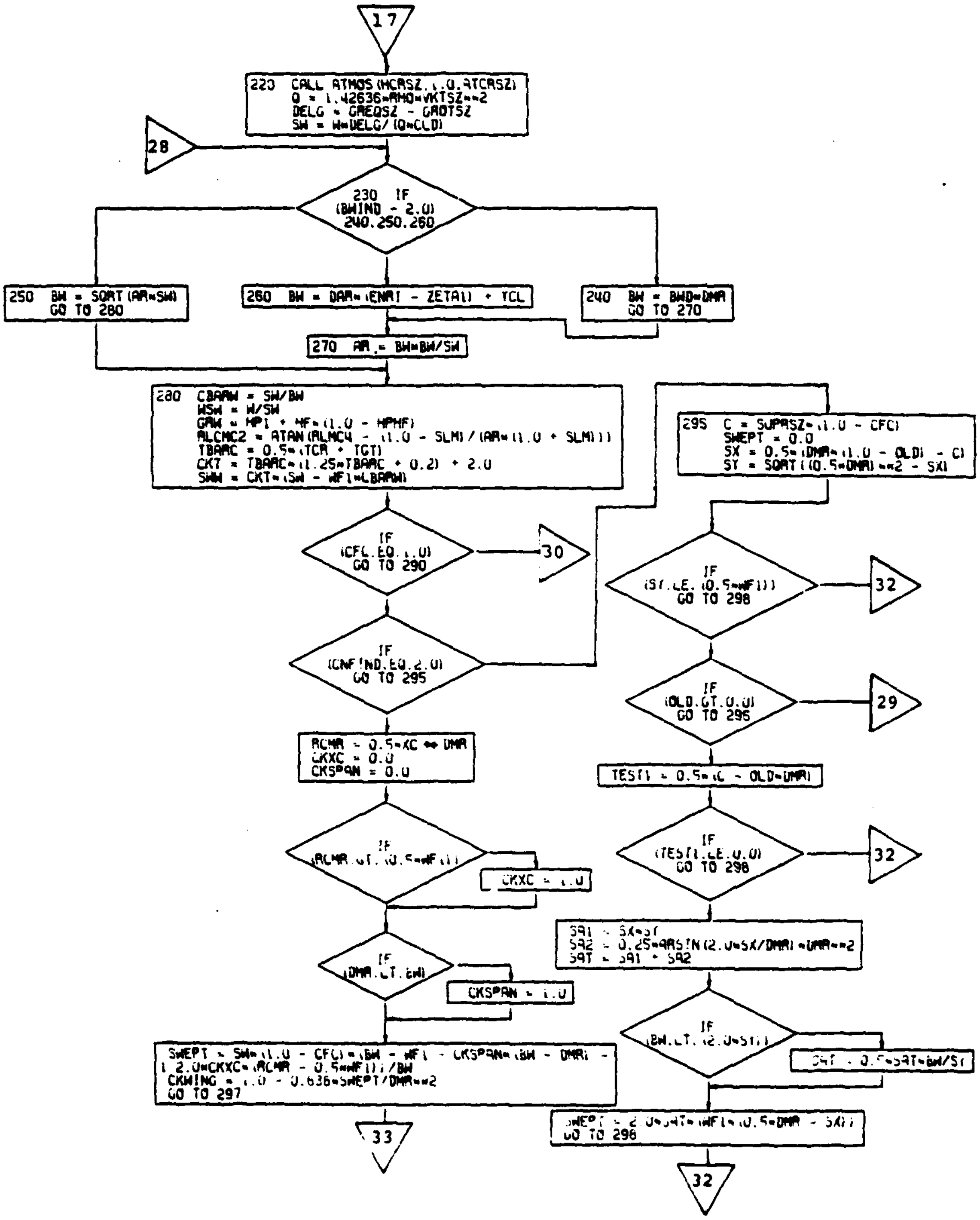


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 7 of 12)

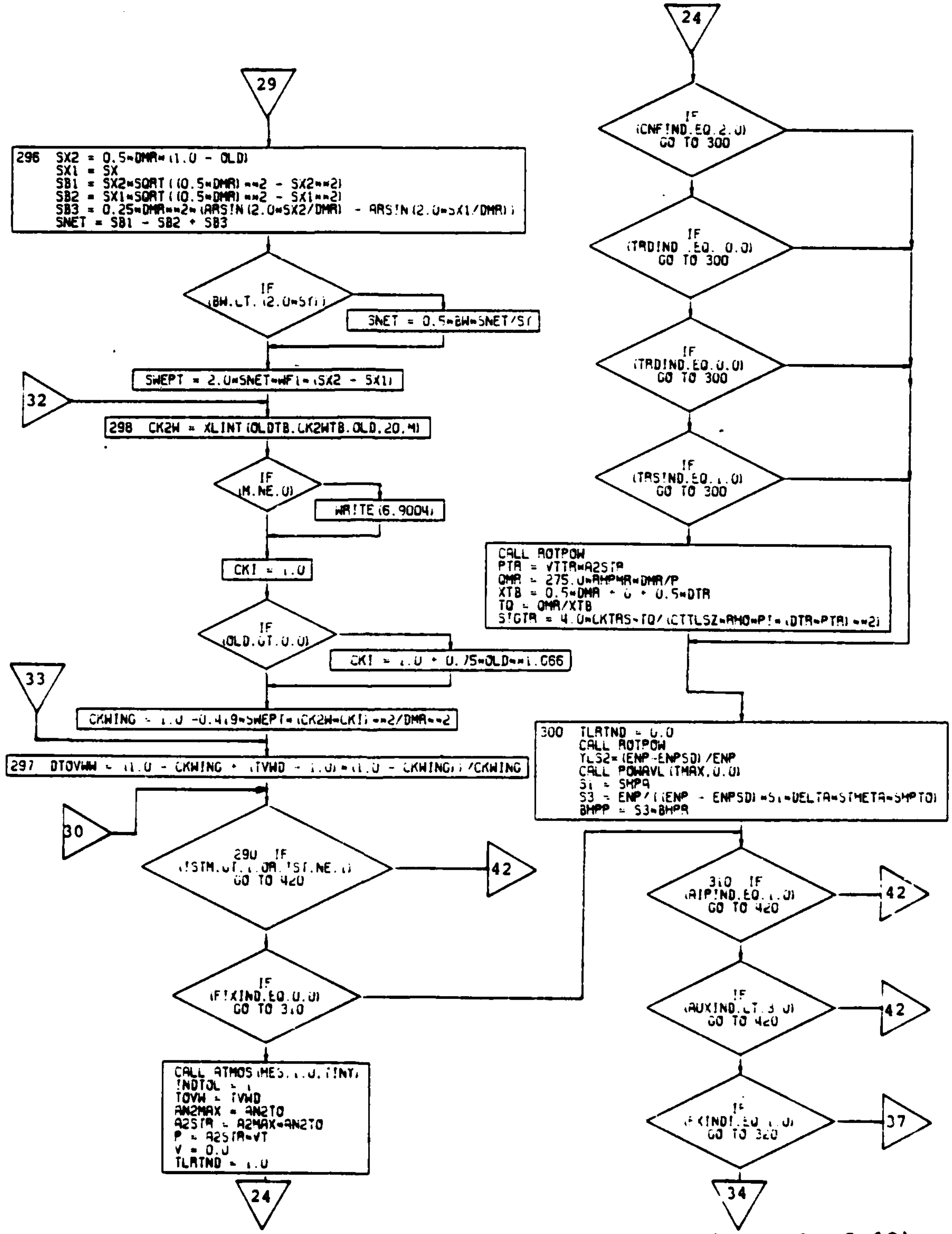


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 8 of 12)

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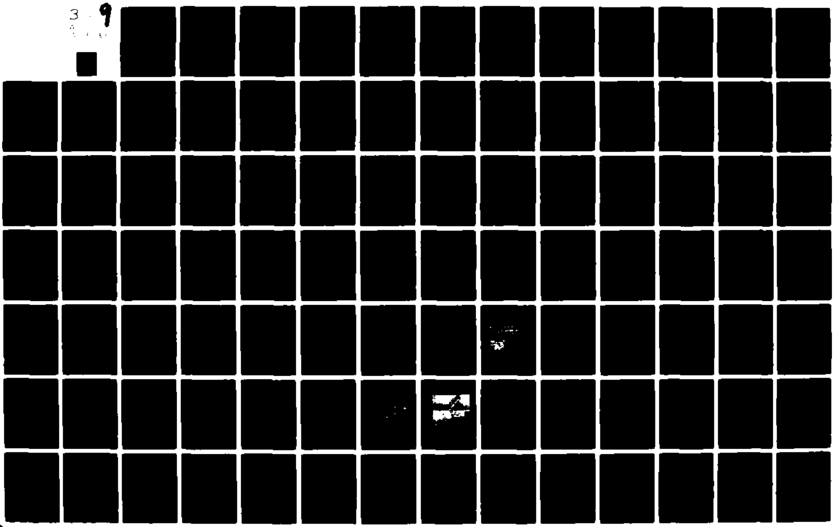

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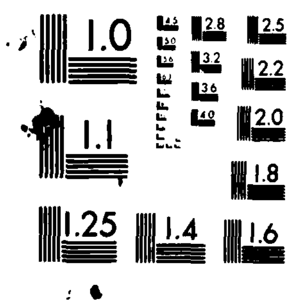

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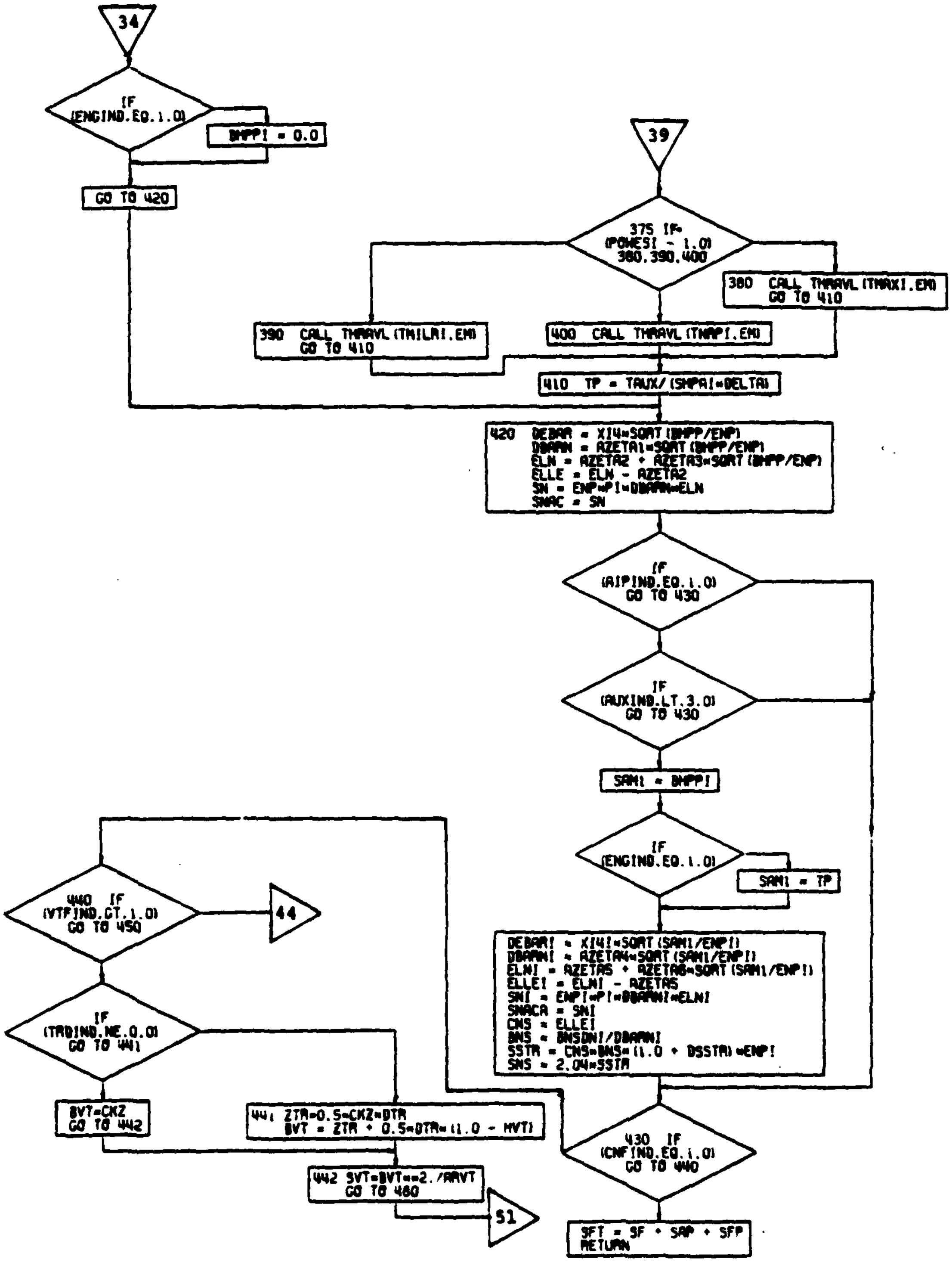


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 9 of 12)

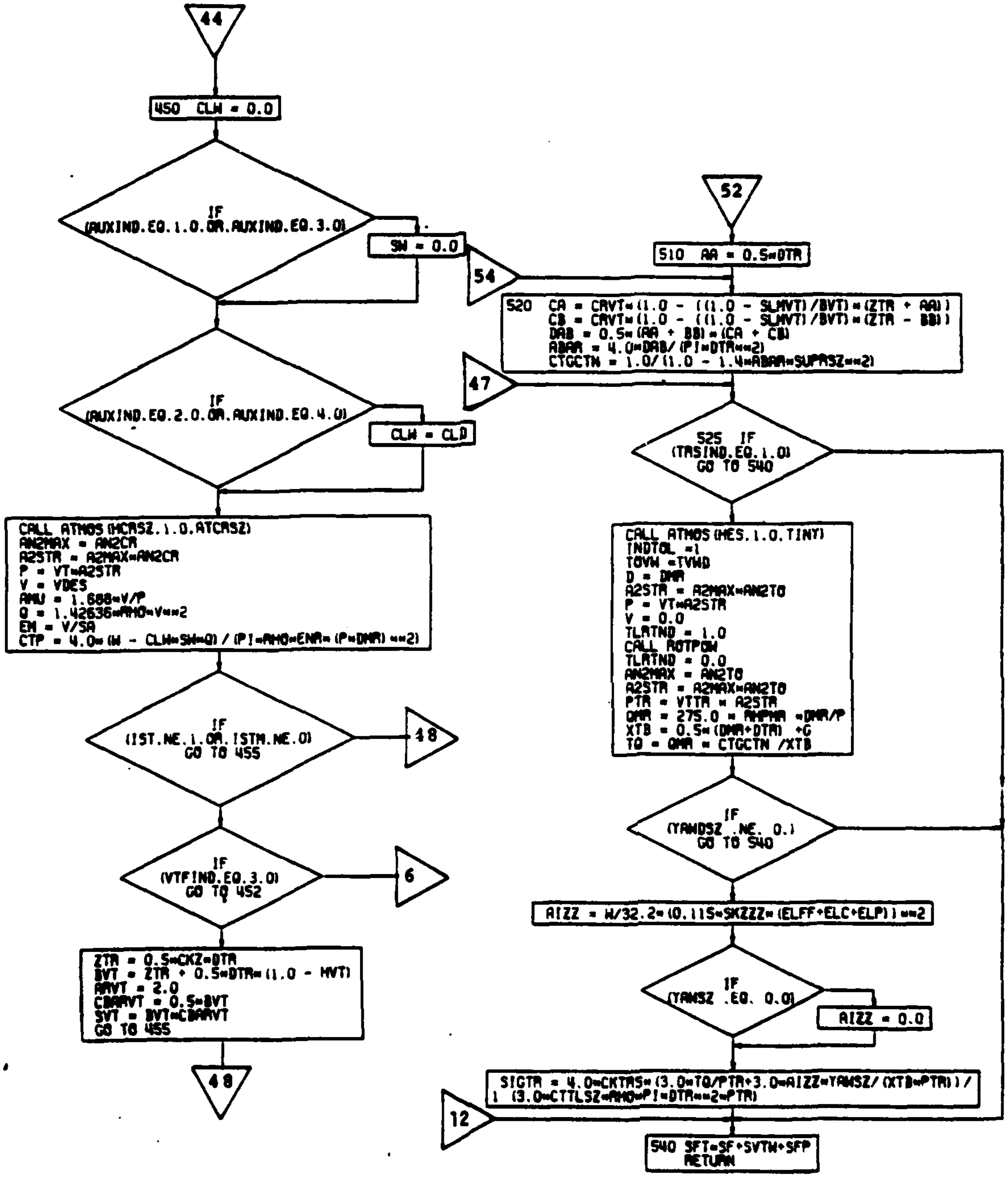


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 10 of 12)

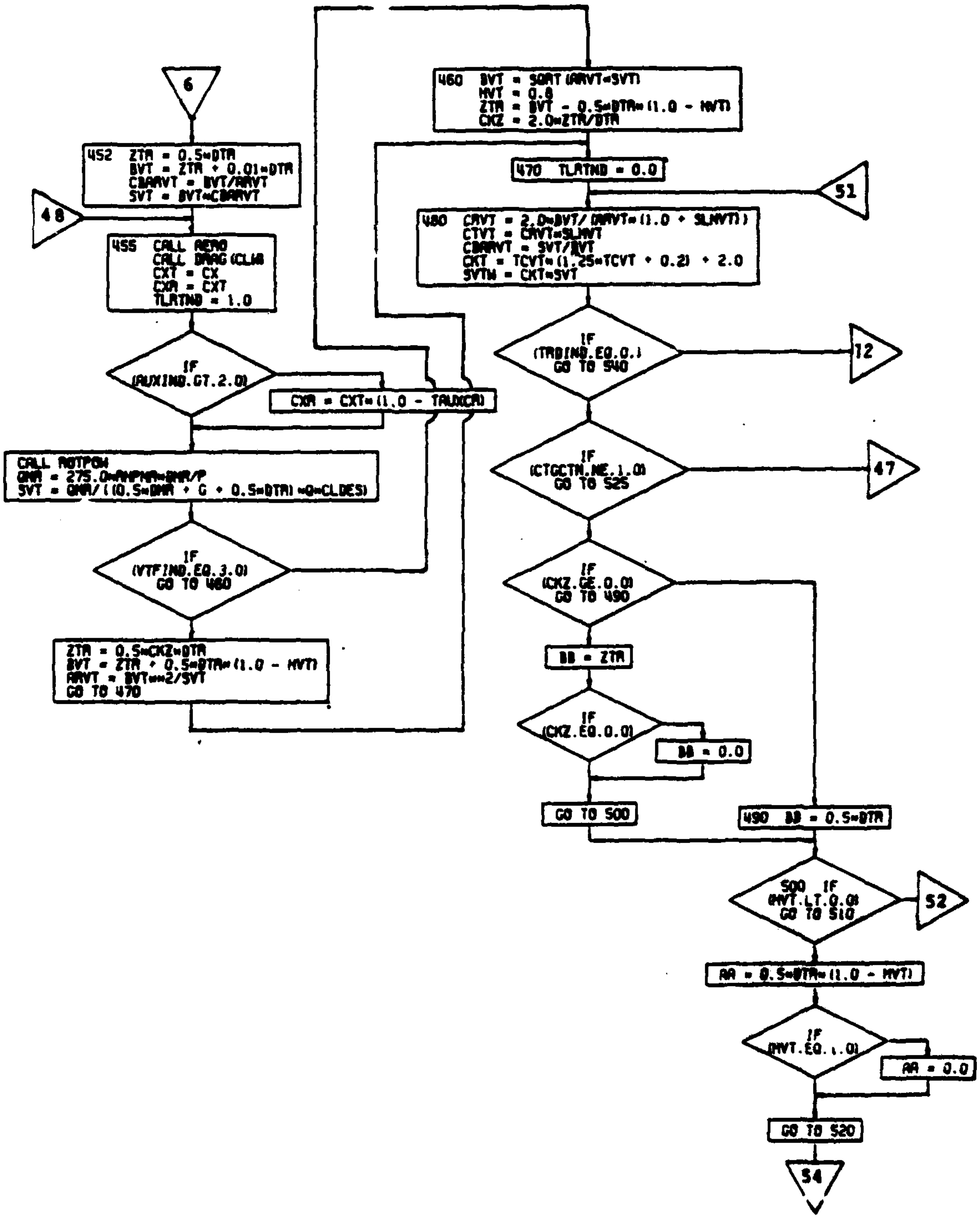


Figure 4-29. SIZTR Subroutine. Flow Chart (Part 11 of 12)

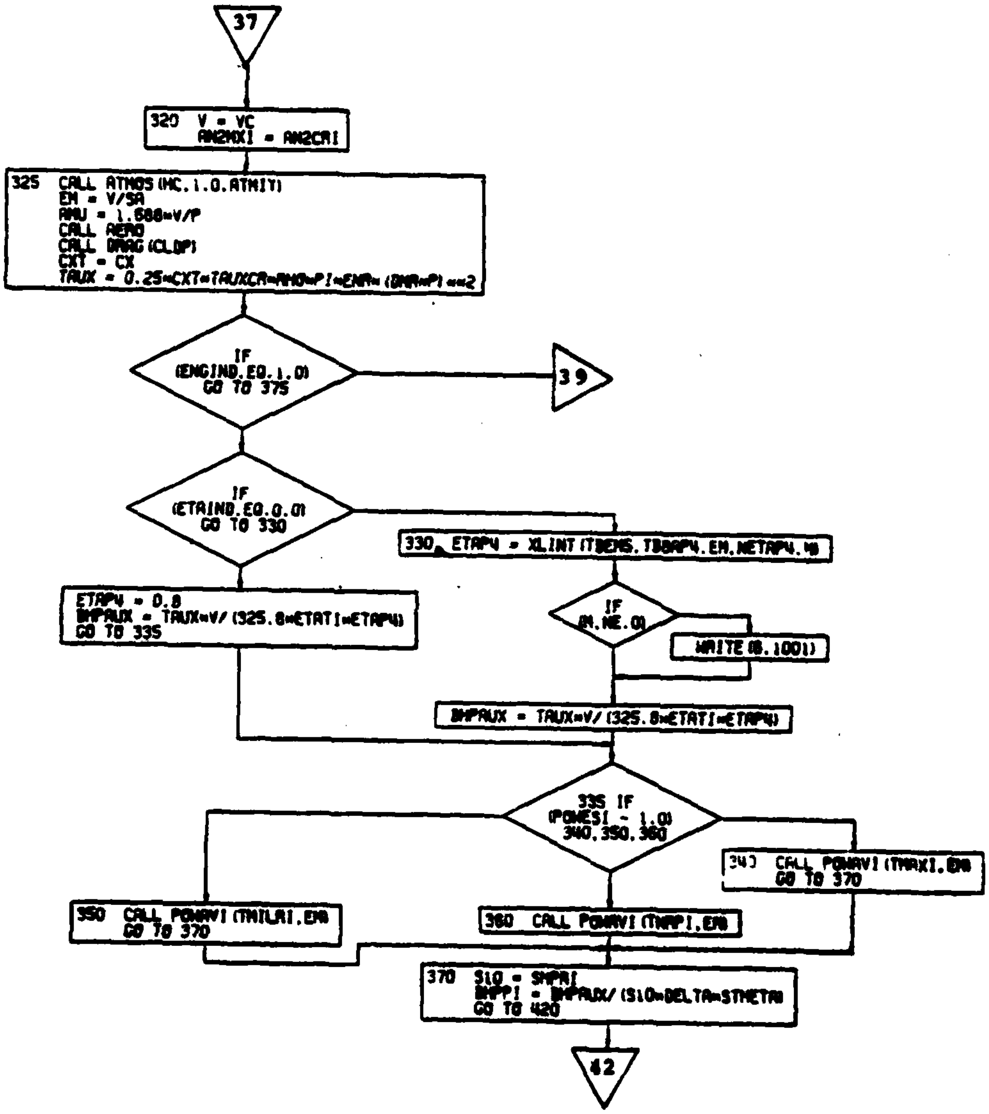


Figure 4-29. SIZTR Subroutine, Flow Chart (Part 12 of 12)

4.9 AERODYNAMICS CALCULATIONS SUBROUTINE

The aerodynamics subroutine calculates a series of factors (a_5, a_6, a_7, a_8, and a_9) which are used in the calculation of drag. The drag calculation has been written in the most general manner possible. Drag is assumed to be divided into profile, induced, and interference components; namely,

$$Fe_{TOT} = a_5 + \underbrace{a_6\, C_{D_{W_i}}\, S_W}_{\text{Wing Profile Drag}} + \underbrace{a_7\, {C_{L_W}}^2\, S_W}_{\text{Wing Induced Drag}} + \underbrace{a_9\, {C_{L_{FIN}}}^2\, S_{VT}}_{\text{Vertical Tail Induced Drag}} + Fe_{IF}$$

where,

Fe_{TOT} = Total configuration equivalent flat plate drag area

a_5 = Basic configuration flat plate drag area (including fuselage, rotor hubs, rotor pylons, etc).

$a_6 = K_W\, [fw\ (Re)]$

$a_7 = 1/\Pi e\ AR$

$a_9 = 1/\Pi e_{VT}\ AR_{VT}\ TFEF$

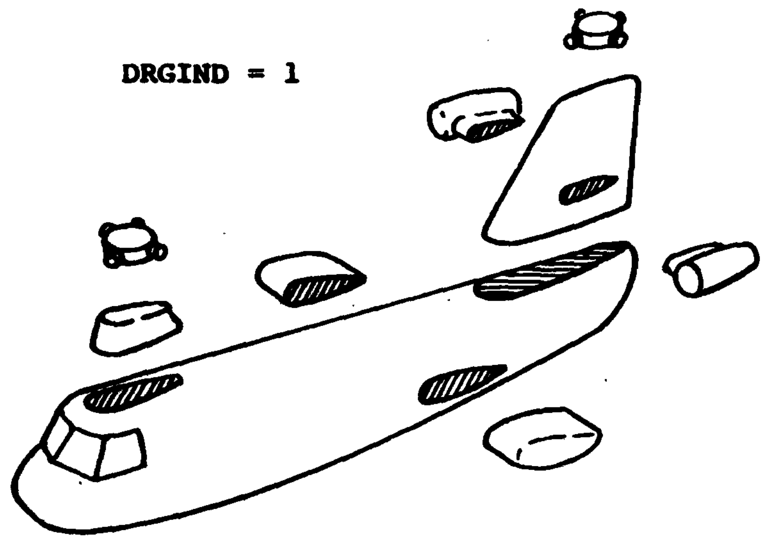
Fe_{IF} = Rotor/wing interference equivalent flat plate drag area (calculated by the program using simplified Prandtl Bi-Plane Theory).

The basic configuration flat plate drag area may be calculated in two different ways: by a detailed build up, or by a trend (see Figure 4-30). The wing profile drag is assumed to be a function of lift coefficient, as specified by an input table.

If the user elects to determine the basic configuration flat plate drag area (a_5) by build up (DRGIND = 1), then profile drag coefficients ($C_{D_{HT}}$, $C_{D_{VT}}$, etc.) and form factors (K_{HT}, K_{VT}, etc.) for each component are input to the program, a_5 then being calculated from the following relationship:

$$a_5 = \underbrace{.00287\, K_F\, S_F\, [f_F\ (Re)]}_{\text{Fuselage Profile Drag}} + \underbrace{K_{FP}\, C_{D_{FP}}\, FA_{FP}}_{\text{Forward (Main) Rotor Pylon Profile Drag}}$$

DRGIND = 1



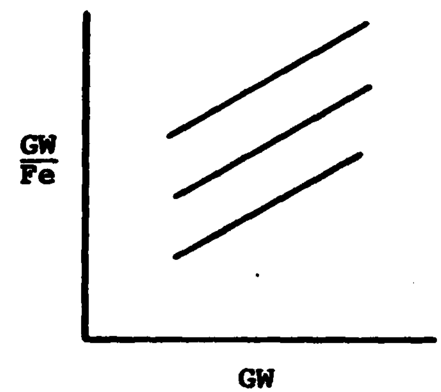
$$Fe_{TOT} = \sum KC_D S \, f\,(Re) + \Delta Fe_{HUB(S)}$$

where:

$$f\,(Re) = \left[1 + \frac{1}{7}\log_{10}\left(\frac{Re}{10^7}\right)\right]^{-2.6}$$

$$Re = (Re/\ell)\,\ell_{CHAR}$$

DRGIND = 2



$$Fe_{TOT} = \left(\frac{W_{G_O}}{(GW/Fe)}\right)\left[\frac{W_G}{W_{G_O}}\right]^{K_{FED}}$$

Figure 4-30. Parasite Drag Buildup Options.

$$+ \underbrace{K_{AP}\, C_{D_{AP}}\, S_{AP}\, [f_{AP}\,(Re)]}_{\text{Aft Rotor Pylon Profile Drag}} + \underbrace{K_{VT}\, C_{D_{VT}}\, S_{VT}\, [f_{VT}\,(Re)]}_{\text{Vertical Fin Profile Drag}}$$

$$+ \underbrace{K_{HT}\, C_{D_{HT}}\, S_{HT}\, [f_{HT}\,(Re)]}_{\text{Horizontal Tail Profile Drag}} + \underbrace{K_{N}\, C_{D_{N}}\, S_{N}\, [f_{N}\,(Re)]}_{\text{Primary Engine Nacelle(s) Profile Drag}}$$

$$+ \underbrace{K_{NI}\, C_{D_{NI}}\, S_{NI}\, [f_{NI}\,(Re)]}_{\text{Auxiliary Independent Engine Nacelle Profile Drag}} + \underbrace{K_{NS}\, C_{D_{NS}}\, S_{NS}\, [f_{NS}\,(Re)]}_{\text{Auxiliary Independent Engine Nacelle Strut Profile Drag}}$$

$$+ \underbrace{\Delta Fe_{MRH}\, N_R}_{\text{Main Rotor Hub(s) Total Drag}} + \underbrace{\Delta Fe_{TRH}}_{\text{Tail Rotor Hub Total Drag}} + \underbrace{\Delta Fe\, [f_F\,(Re)]}_{\text{Miscellaneous Drag}}$$

NOTE: If OPTIND=2, $A5=\Delta F_e$

The terms f_W (Re), f_F (Re), f_{VT} (Re), etc., are Reynolds number functions for the wing, fuselage, vertical tail, etc., which reflect the variation of skin friction coefficient with Reynolds number. The function which is used is a normalized form of the Prandtl-Schlichting turbulent flat plate skin friction equation:

$$f(Re) = \frac{C_f}{C_{f_{Re=10^7}}} = \left[1 + \frac{1}{7} \log_{10} \frac{R_e}{10^7}\right]^{-2.6}$$

The program user inputs a value for average Reynolds number per foot for the mission and the program then calculates the Reynolds' number for each component of the aircraft and uses the Reynolds' number functions f_W (Re), f_F (Re), etc., to determine the variation in component drag as the aircraft dimensions change during the iteration on gross weight. The individual profile drag coefficients, $C_{D_{VTi}}$, $C_{D_{HTi}}$, etc., are input at a reference Reynolds number of 10^7.

Particular care must be exercised in the input of data required for calculating the hub drag, as this particular component can typically account for as much as 1/2 to 2/3 of the

total parasite drag of a helicopter. The hub drag calculation method (Reference 8) used in this program is based on the following relationships:

$$\Delta Fe_{HUB} = \underbrace{Fe_{HUB_{CS}}}_{\text{Hub center}} + \underbrace{Fe_{SH}}_{\text{Rotor shanks}} + \underbrace{Fe_{INT}}_{\text{Misc hub/shank Interference}}$$

where:

$$Fe_{HUB_{CS}} = f\left\{C_{D_{CS}} \text{ (Hub projected frontal area)}\right\}$$

$$Fe_{SH} = f\left\{C_{D_{SH}}, \text{ Number of shanks, shank projected frontal area, and local advance ratios at the hub/shank and shank/rotor blade interfaces}\right\}$$

Typical values of hub center section and shank drag coefficients are illustrated in Figure 4-31. A few notes of caution on the use of values such as are contained in Figure 4-31 is in order. First, estimates of the Reynolds number of the hub or shank sections to be used should be made in order to establish whether the sections are sub or super critical. Second, while 2-dimensional section drag coefficients are appropriate for use with shanks of extended length, test data indicates that 3-dimensional coefficients are more representative for low aspect ratio shanks bounded by lower drag shapes (for example, a short stubby shank bounded on one side by a faired hub and on the other side by the root end of the rotor blade). Figure 4-32 illustrates the hub geometry and interference drag factors implicitly assumed in this program. If the actual hub geometry or interference drag variation desired by the user differs appreciably from these, the differences can be reflected by ratioing the input drag coefficients $C_{D_{CSMR}}$, $C_{D_{SHMR}}$, $C_{D_{CSTR}}$, and $C_{D_{SHTR}}$ accordingly. Table 4-5 summarizes these corrections.

If it is desired to calculate a_5 by use of a drag trend (DRGIND = 2), the following relationship then obtains:

$$a_5 = \left[\frac{W_{G_O}}{(G_W/Fe)}\right]\left[\frac{W_G}{W_{G_O}}\right]^{K_{FED}}$$

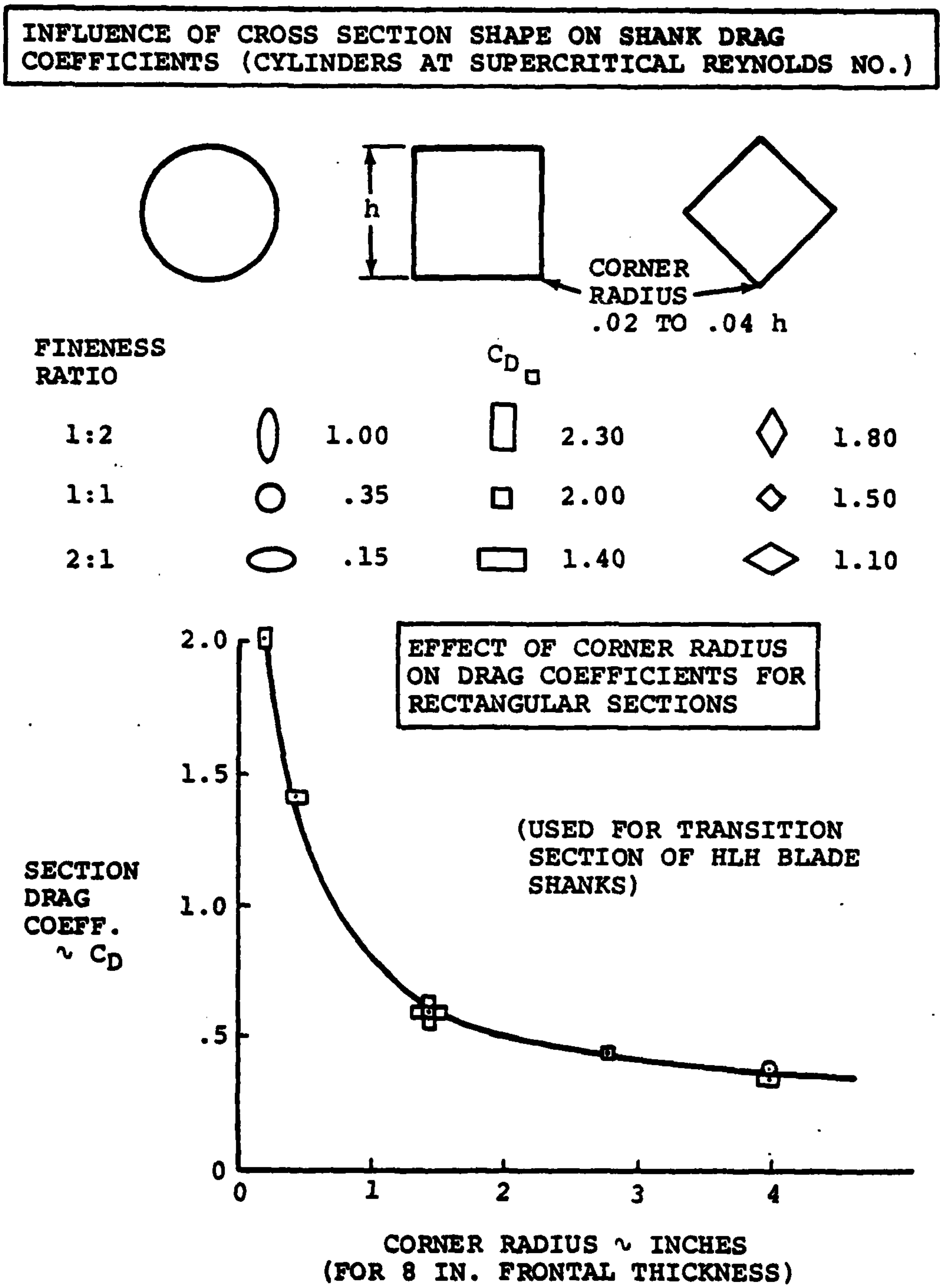


Figure 4-31. Typical Hub and Shank Drag Coefficients (Part 1 of 2).

HUB CENTERSECTION DRAG COEFFICIENTS

CH-47 HUB (INCLUDING INTERFERENCE)

@ $\alpha_{FUSE} = 0$ $C_D = 1.61$

@ $\alpha_{SHAFT} = 0$ $C_D = 1.91$

CH-47 HUB (WITH INTERFERENCE CORRECTION)

BASED ON STATIC AREA $C_D = 1.03$

BASED ON ROTATING AREA $C_D = .88$

DRTS/12' DIA. - 3/6 BLADED ROTOR HUB (NO INTERFERENCE)

BASED ON STATIC AREA $C_D = 1.03$

BASED ON ROTATING AREA $C_D = .88$

NASA MEMO 1-31-59L (NO INTERFERENCE)

BASED ON ROTATING AREA

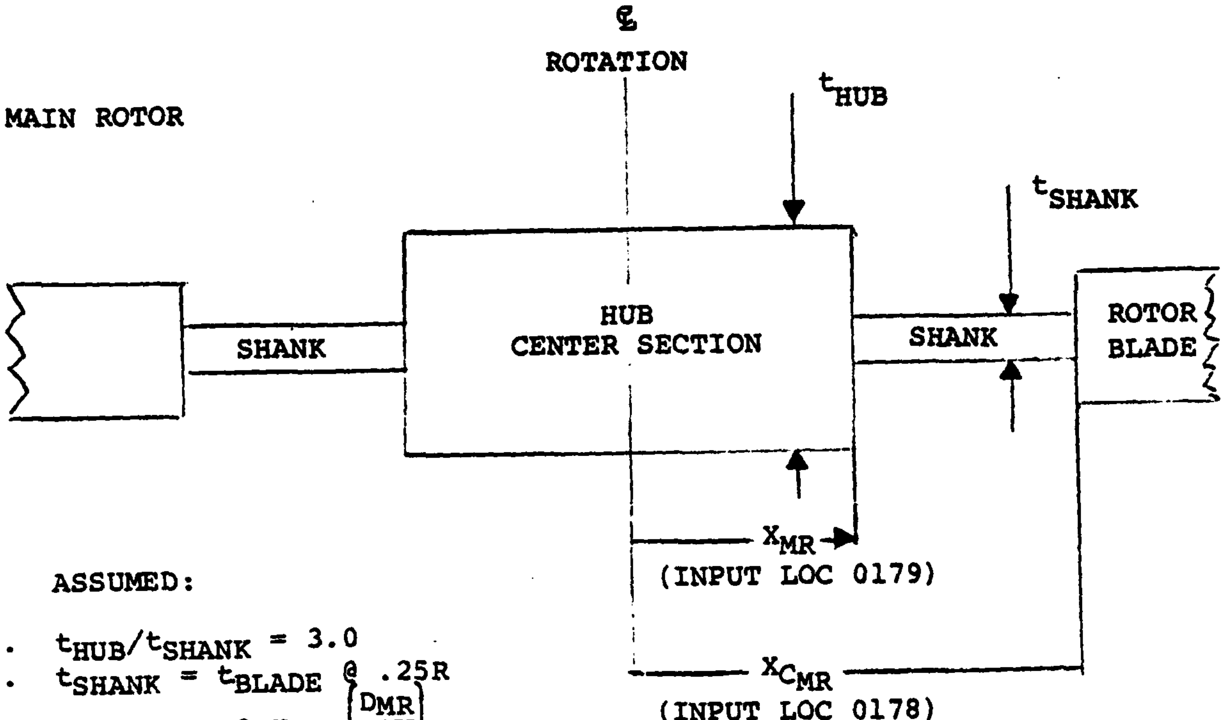
HUB 1	CYLINDRICAL HUB	$C_D = .65$
HUB 2	TWO BLADED TEETERING HUB	$C_D = .63$
HUB 3	HILLER SERVO ROTOR HUB	$C_D = .70$
HUB 4	H-19 HUB	$C_D = .72$
HUB 5	HUP-2 HUB	$C_D = .55$

NOTE: HUB CENTERSECTION COEFFICIENTS ARE GENERALLY LOWER THAN MIGHT BE EXPECTED SINCE CENTERSECTION IS USUALLY MORE TYPICAL OF 3 DIMENSIONAL RATHER THAN 2 DIMENSIONAL FLOW

SHAPE	C_D @ SUBCRITICAL REYNOLDS NO. 3-DIMENSIONAL TYPICAL OF CENTERSECTION	2-DIMENSIONAL TYPICAL OF SHANKS
○	.47	1.17
◇	.80	1.55
□	1.05	2.05
│	1.17	1.98

Figure 4-31. Typical Hub and Shank Drag Coefficients (Part 2 of 2).

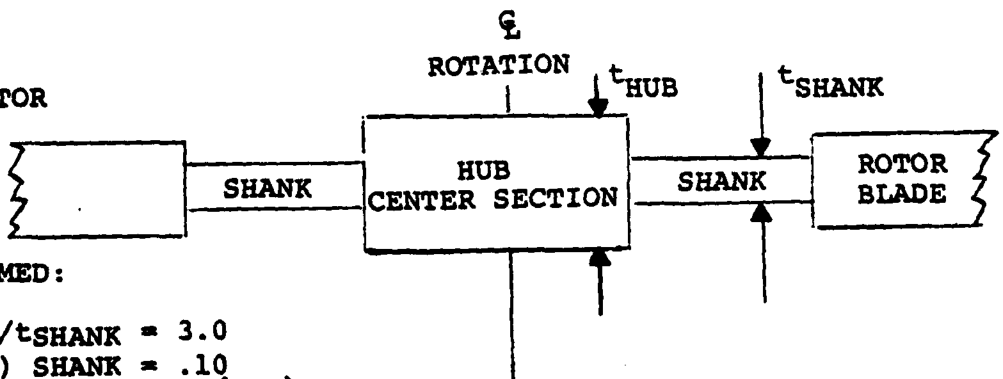
MAIN ROTOR



ASSUMED:

1. $t_{HUB}/t_{SHANK} = 3.0$
2. $t_{SHANK} = t_{BLADE}$ @ .25R
3. HUB DIA $= 2\ X_{MR} \left(\frac{D_{MR}}{2}\right)$
4. HUB FRONTAL AREA = HUB DIA X t_{HUB}
5. SHANK FRONTAL AREA $= (X_{C_{MR}} - X_{MR}) \left(\frac{D_{MR}}{2}\right) t_{SHANK}$
6. $K_{INT} = 1.00$

TAIL ROTOR



ASSUMED:

1. $t_{HUB}/t_{SHANK} = 3.0$
2. (t/c) SHANK = .10
3. HUB DIA $= 2\ X_{TR} \left(\frac{D_{TR}}{2}\right)$
4. HUB FRONTAL AREA = HUB DIA X t_{HUB}
5. SHANK FRONTAL AREA $= (X_{C_{TR}} - X_{TR}) \left(\frac{D_{TR}}{2}\right) t_{SHANK}$
6. $K_{INT} = 1.00$

Figure 4-32. Rotor Hub/Shank Geometry Used in Program for Hub Drag Calculations.

TABLE 4-5. HUB AND SHANK DRAG COEFFICIENTS CORRECTION SUMMARY

MAIN ROTOR

$$C_{D_{CSMR}} = C_{D_{CSMR}} \left[\frac{(t_{HUB}/t_{SHANK})_{MR}}{3.0}\right] \left[\frac{(t/C)_{SHANK}}{(t/C)_{.25R}}\right] \left[\frac{X_{MR}}{X_{MR}}\right] \left[\frac{K_{INT}}{1.00}\right]^{*}$$

OBT FROM FIG 4-25   INPUT LOC 0180   INPUT LOC 0179

$$C_{D_{SHMR}} = C_{D_{SHMR}} \left[\frac{(t/C)_{SHANK}}{(t/C)_{.25R}}\right] \left[\frac{(X_{C_{MR}} - X_{MR})}{(X_{C_{MR}} - X_{MR})}\right] \left[\frac{K_{INT}}{1.00}\right]^{*}$$

INPUT LOC 0180   INPUT LOC 0178   INPUT LOC 0179

TAIL ROTOR

$$C_{D_{CSTR}} = C_{D_{CSTR}} \left[\frac{(t_{HUB}/t_{SHANK})_{TR}}{3.0}\right] \left[\frac{(t/C)_{SHANK}}{.10}\right] \left[\frac{K_{INT}}{1.00}\right]^{*}$$

OBT FROM FIG. 4-25

$$C_{D_{SHTR}} = C_{D_{SHTR}} \left[\frac{(t/C)_{SHANK}}{.10}\right] \left[\frac{K_{INT}}{1.00}\right]^{*}$$

*NUMERATORS SHOW ACTUAL HUB/SHANK CHARACTERISTICS DESIRED. DENOMINATORS SHOW FIXED CHARACTERISTICS.

where,

W_{G_O} = Initial "guess" at iterated helicopter gross weight (input LOC 0023) Note, this is also the value of gross weight at which the input value of (GW/Fe) is obtained. (See sketch below)

W_G = "Iterated" or final design gross weight of the aircraft.

(GW/Fe) = "Drag Loading" input at a given gross weight (in this case W_{G_O}).

K_{FED} = Exponent defining the slope of a typical logarithmic drag trend.

The following sketch should serve to illustrate these facts more clearly.

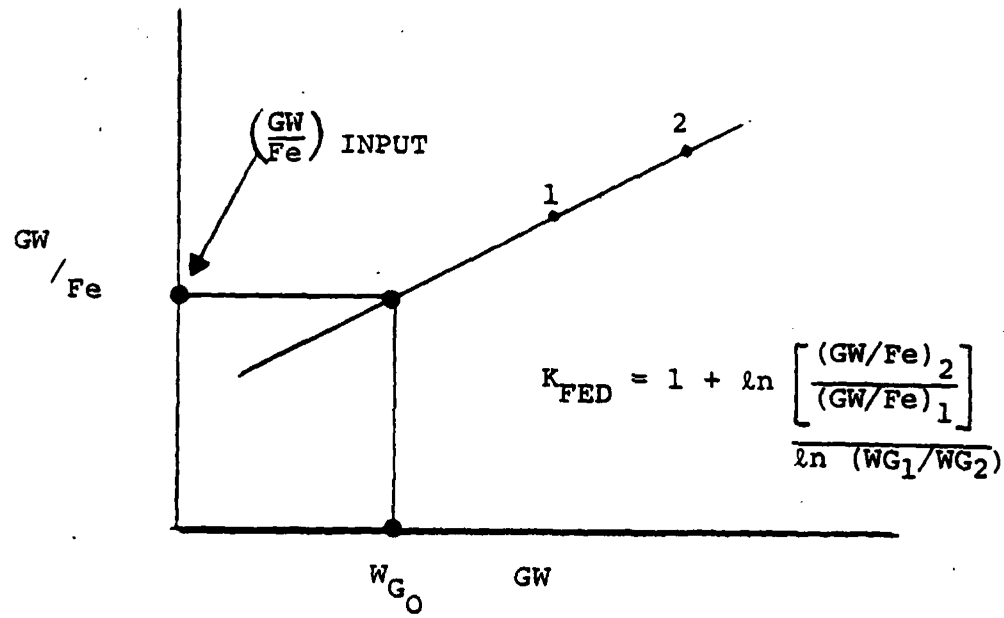
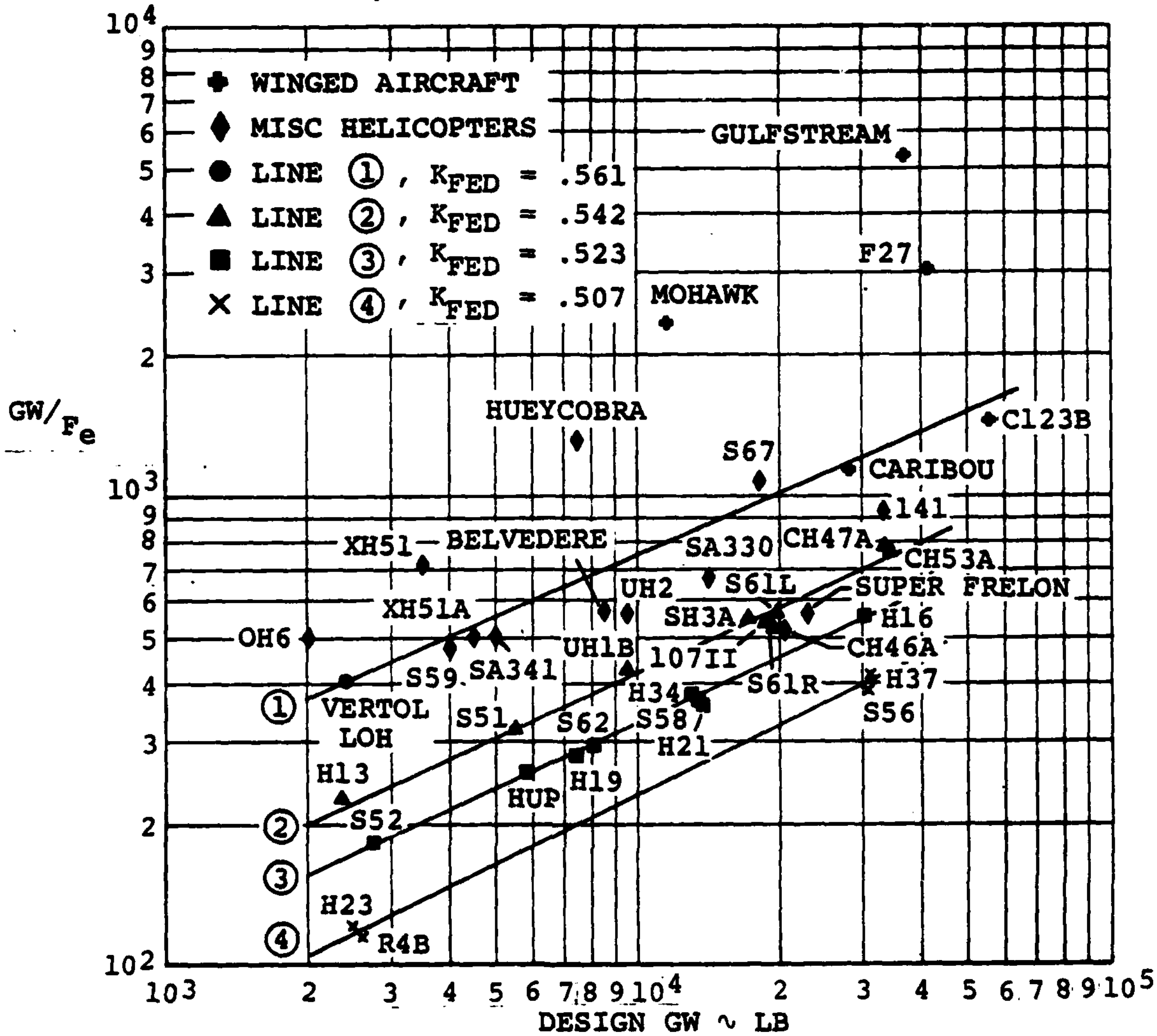


Figure 4-33 illustrates typical parasite drag area trend for various helicopters and fixed-wing aircraft.

The drag routine may be used in many different ways. The four most common applications are:

1. Drag Build up for a New Aircraft Design - This is best illustrated by first referring to the complete drag breakdowns of the hypothetical helicopters shown in Tables 4-6 and 4-8. The input C_D for each component (C_{DWi}, $_{DHTi}$,



1. Advanced drag cleanup (e.g. faired hubs, low drag or retractable landing gear etc.).
2. Current standard of landing gear, hub design, skin finish etc.
3. Unfaired landing gear, hubs, protuberances, poor body shape, etc.
4. Exceptionally dirty configuration due to such things as open construction, exceptionally dirty engine installation, landing gear, etc.

NOTE: The drag area for the winged aircraft excludes the C_DA of the wings, to be compatible with the helicopters.

Figure 4-33. Typical Parasite Drag Trends.

etc.) may be used to represent the reference C_f at Re = 10^7 and at the mean flight Mach number. Drag increases above the drag of a flat plate such as three dimensional effects, interference, roughness, and excrescences may be accounted for by the multiplying factors (K_W, K_{HT}, etc.). Miscellaneous drag increments can be summed and input as ΔFe. Examples of these increments are cooling momentum, trim, and airconditioning. The K factor for wings and tails should include a factor for relating the wetted area of the surface to the planform area. An example of the program inputs for the hypothetical helicopters of Tables 4-6 and 4-8 are shown in Tables 4-7 and 4-9.

2. Study of the Sensitivity of Aircraft Size with Respect to the Component Drag or the Total Drag about a Certain Drag Level - Let the total drag of each component be contained in the drag coefficient of each component, C_{DWi}, C_{DHTi}, C_{DVTi}, etc. The change in drag of each component will then be determined by the values assigned to the component multiplying factor, K_W, K_{HT}, K_{VT}, etc. The fuselage drag change, however, will have to be represented by an incremental value of Δfe.

3. Use of Component Drag Data from Wind Tunnel Test - Let the drag of each component (including interference) be contained in the component drag coefficient, C_{DWi}, C_{DHTi}, C_{DVTi}, etc. The skin friction drag must first be corrected to Re = 10^7. The drag increase due to items found only on the full scale airplane would then be represented by the factors and increments. Increases due to excrescences and roughness are represented by the factors, K_W, K_{HT}, K_{VT}, etc. Increments such as inlets, cooling, trim, and afterbody drag, can be summed and represented by Δfe.

4. Simplified Drag Model for Parametric Studies - The program is often used to study the influence of variations of parameters, such as disc loading, solidity, etc. on the size of a helicopter. During these studies, it is often not desirable to go into the design depth required in the three applications above. Use of the drag trends (DRGIND = 2) is therefore dictated by this requirement.

Figure 4-34 is a flow chart of this subroutine.

TABLE 4-6. DRAG BREAKDOWN FOR HYPOTHETICAL SINGLE ROTOR COMPOUND HELICOPTER $R_e/FT = 1.56 \times 10^6$ (V = 189 KT)

COMPONENT	WETTED AREA	C_f	INCREMENT %	INCREMENT Δf_e	f_e FT^2
FUSELAGE	1949.	0.00191		3.72	6.60
3-Dimensional Effects			12.3	0.46	
Excrescences			7.0	0.29	
Canopy				0.20	
Afterbody				1.93	
WING	345.	0.0030		1.04	1.59
3-Dimensional Effects			29.3	0.31	
Excrescences			2.0	0.03	
Flaps, Slats, Ailerons, Spoilers			-	-	
Body Interference			15.6	0.21	
MAIN ROTOR PYLON	286.				3.19
Basic F_e (including interference and 3-D effects) C_{D_O} (Based on frontal area) = 0.10	Frontal Area = 26.6 Ft^2			2.66	
Excrescences			20.0	0.53	
HORIZONTAL TAIL	246.	0.00305		0.75	1.60
3-Dimensional Effects			43.4	0.33	
Excrescences			7.0	0.08	
Interference			40.7	0.44	
VERTICAL TAIL	210.	0.00270		0.57	1.03
3-Dimensional Effects			22.3	0.13	
Excrescences			7.0	0.05	
Interference			40.7	0.28	
PRIMARY ENGINE NACELLES	188.	0.00278		0.52	1.72
3-Dimensional Effects			40.4	0.21	
Excrescences			25.0	0.18	
Interference			75.0	0.55	
Inlets				0.26	
ROTOR HUBS (TOTAL)					14.82
Main Rotor Hub (center section)				6.22	
Main Rotor Hub (shanks)				5.85	
Tail Rotor Hub (center section)				0.48	
Tail Rotor Hub (shanks)				0.67	
Total Interference (main & tail rotor)				1.60	
MISC: Roughness (50% of C_f A_{WET}				0.54	1.34
MISC: Cooling				0.50	
MISC: Trim				-	
MISC: Air Conditioning				0.30	
TOTALS ft^2	3224				31.89

NOTES: (1) Basic $f_e = (C_f A_{WET}) + (3\text{-D Effects } \Delta f_e)$

(2) Excrescences and interference are % of basic f_e

TABLE 4-7. SUMMARY OF AERODYNAMICS INPUT FOR COMPOUND HELICOPTER OF TABLE 4-6

GENERAL	$C_{D_{Wi}} = C_{D_{HT}} = C_{D_{VT}} = C_{DN} = C_F = 0.00287$ @ $R_e = 10^7$ $(R_e/\ell)_i = 1.56 \times 10^6$
COMPONENTS	$S_F = 1949$ FUSELAGE WETTED AREA
FUSELAGE	$K_F = \underbrace{(1+0.123)}_{\text{3-D effects}}\ (1+\underbrace{0.07}_{\text{excr}}) + \underbrace{0.05}_{\text{roughness}} = 1.25$ $\Delta F_e = \underbrace{\left(\frac{0.00287}{0.00191}\right)}_{\text{Body } C_F} (\underbrace{1.93}_{\text{Afterbody}} + \underbrace{0.20}_{\text{Canopy}} + \underbrace{0.26}_{\text{Nacelle inlets}} + \overbrace{0.30}^{\text{Cooling}} + \overbrace{0.30}^{\text{Air Condit.}}) = 4.80$
WING	$K_W = \underbrace{(1.80)}_{(A_{wet}/S_W)}\ [(1 + \underbrace{0.293}_{\text{3-D effects}})\ (1 + \underbrace{0.02}_{\text{excr}} + \underbrace{0.156}_{\text{interf}}) + \underbrace{0.05}_{\text{roughness}}] = 2.83$
MAIN PYLON	$K_{PP} = 1 + \underbrace{0.20}_{\text{excr}} + \underbrace{0.05}_{\text{roughness}} = 1.25$ $C_{D_{PP}} = 0.10$
HOR & VERTICAL TAIL	$K_{HT} = \underbrace{2.02}_{(A_{wet}/S_{HT})}\ [(1 + \underbrace{0.434}_{\text{3-D effects}})\ (1 + \underbrace{0.07}_{\text{excr}} + \underbrace{0.407}_{\text{interf}}) + \underbrace{0.05}_{\text{roughness}}] = 4.38$ $K_{VT} = \overbrace{2.06}^{(A_{wet}/S_{VT})}\ [(1 + 0.223)\ (1 + 0.07 + 0.407) + 0.05] = 3.83$
PRIMARY ENGINE NACELLES	$K_N = (1 + \underbrace{0.404}_{\text{3-D effects}})\ [1 + \underbrace{0.25}_{\text{excr}} + \underbrace{0.75}_{\text{interf}}] + \underbrace{0.05}_{\text{roughness}} = 2.86$
ROTOR HUBS	$C_{D_{C_{SMR}}} = 0.75$ $C_{D_{SHMR}} = 1.4$ $K_{HPIM} = 1.3$ $C_{D_{CSTR}} = 0.75$ $C_{D_{SHTR}} = 1.4$ $K_{HPSM} = 0.3$
MISC	Cooling, Airconditioning, and nacelle inlets included in fuselage ΔF_e

TABLE 4-8. TYPICAL DRAG SUMMARY DRAG BREAKDOWN FOR HYPOTHETICAL TANDEM ROTOR WINGED HELICOPTER $R_e/ft = 1.49 \times 10^6$ (V = 181 KT)

COMPONENT	WETTED AREA	C_f	INCREMENT %	INCREMENT f_e	f_e FT^2
FUSELAGE	1640.	0.00208		3.41	6.52
3-Dimensional Effects			12.2	0.42	
Excrescences			7.0	0.27	
Canopy				0.20	
Afterbody				2.22	
WING	389.	0.0030		1.16	1.77
3-Dimensional Effects			29.3	0.34	
Excrescences			2.0	0.03	
Flaps, Slats, Ailerons, Spoilers			-	-	
Body Interference			15.2	0.24	
FORWARD PYLON	41.5				1.69
Basic f_e (including interference and 3-D effects) C_{D_0} (Based on Frontal Area) = 0.15	(Frontal Area = 9.5 Ft^2)			1.41	
Excrescences			20.0	0.28	
AFT PYLON	421.	0.00252		1.06	2.38
3-Dimensional Effects			46.4	0.49	
Excrescences			20.0	0.31	
Interference			33.5	0.52	
PRIMARY ENGINE NACELLE	188.	0.00278		0.52	1.72
3-Dimensional Effects			40.4	0.21	
Excrescences			25.0	0.18	
Interference			75.0	0.55	
Inlets				0.26	
ROTOR HUBS (TOTAL)					19.48
Main rotor hub (center section, total)				10.4	
Main rotor hub (shanks, total)				7.78	
Hub/Shank Interference (total)				1.30	
MISC: Roughness (5.0% of $C_f A_{WET}$)				0.45	1.25
MISC: Cooling				0.50	
MISC: Trim				-	
MISC: Air Conditioning				0.30	
TOTALS ft^2	2679.5				34.81

NOTES: (1) Basic $f_e = (C_f A_{WET}) + (\text{3-D Effects } \Delta f_e)$

(2) Excrescences and interference are % of basic f_e

TABLE 4-9. SUMMARY OF AERODYNAMICS INPUT FOR HELICOPTER OF TABLE 4-8

GENERAL	
$C_{D_{Wi}} = C_{D_{AP}} = C_{DN} = C_F = 0.00287$ @ $R_e = 10^7$ $(Re/\ell)_i = 1.49 \times 10^6$	
COMPONENTS	$S_F = 1640$ FUSELAGE WETTED AREA
FUSELAGE	$K_F = (1+\underset{\text{3-D effects}}{0.122})\ (1+\underset{\text{excr}}{0.07})\ +\underset{\text{roughness}}{0.05} = 1.25$ $\quad \Delta F_e = \left(\dfrac{\underset{\text{Body } C_F}{0.00287}}{0.00208}\right)(\underset{\text{Afterbody}}{2.22}+\underset{\text{Canopy}}{0.20}+0.26+\overset{\text{cooling}}{0.50}+\overset{\text{air condit}}{0.30}) = 4.81$ (0.26: Nacelle inlets)
WING	$K_W = \underset{\left(\frac{A_{wet}}{S_W}\right)}{(1.80)}\ [(1+\underset{\text{3-D effects}}{0.34})\ (1+\underset{\text{excr}}{0.02}+\underset{\text{interf}}{0.152}) + \underset{\text{roughness}}{0.05}] = 2.92$
FORWARD PYLON	$K_{FP} = 1 + \underset{\text{excr}}{0.20} + \underset{\text{roughness}}{0.05} + 1.25$ $\quad C_{D_{FP}} = 0.15$
AFT PYLON	$K_{AP} = \underset{\left(\frac{S_{PAP}}{A_{wet}}\right)}{(0.455)}\ [(1+\underset{\text{3-D effects}}{0.464})\ (1+\underset{\text{excr}}{0.20}+\underset{\text{interf}}{0.335}) + \underset{\text{roughness}}{0.05}] = 1.045$
PRIMARY ENGINES NACELLES	$K_N = (1+\underset{\text{3-D effects}}{0.404})\ [1+\underset{\text{excr}}{0.25}+\underset{\text{interf}}{0.75}] + \underset{\text{roughness}}{0.05} = 2.86$
ROTOR HUBS	$C_{D_{C_{SMR}}} = 0.75$ $\quad K_{HPIM} = 1.3$ $C_{D_{SHMR}} = 1.4$
MISC	Cooling, air conditioning and nacelle inlets included in fuselage ΔF_e

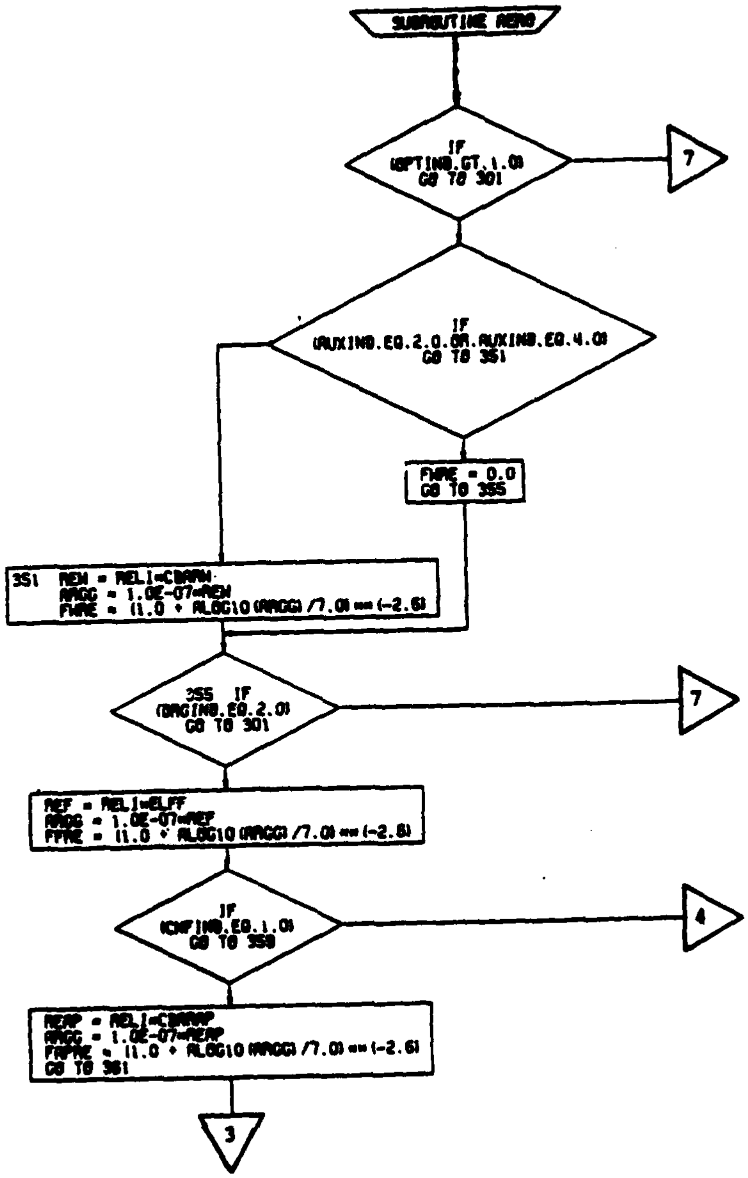


Figure 4-34. AERO Subroutine, Flow Chart (Part 1 of 4)

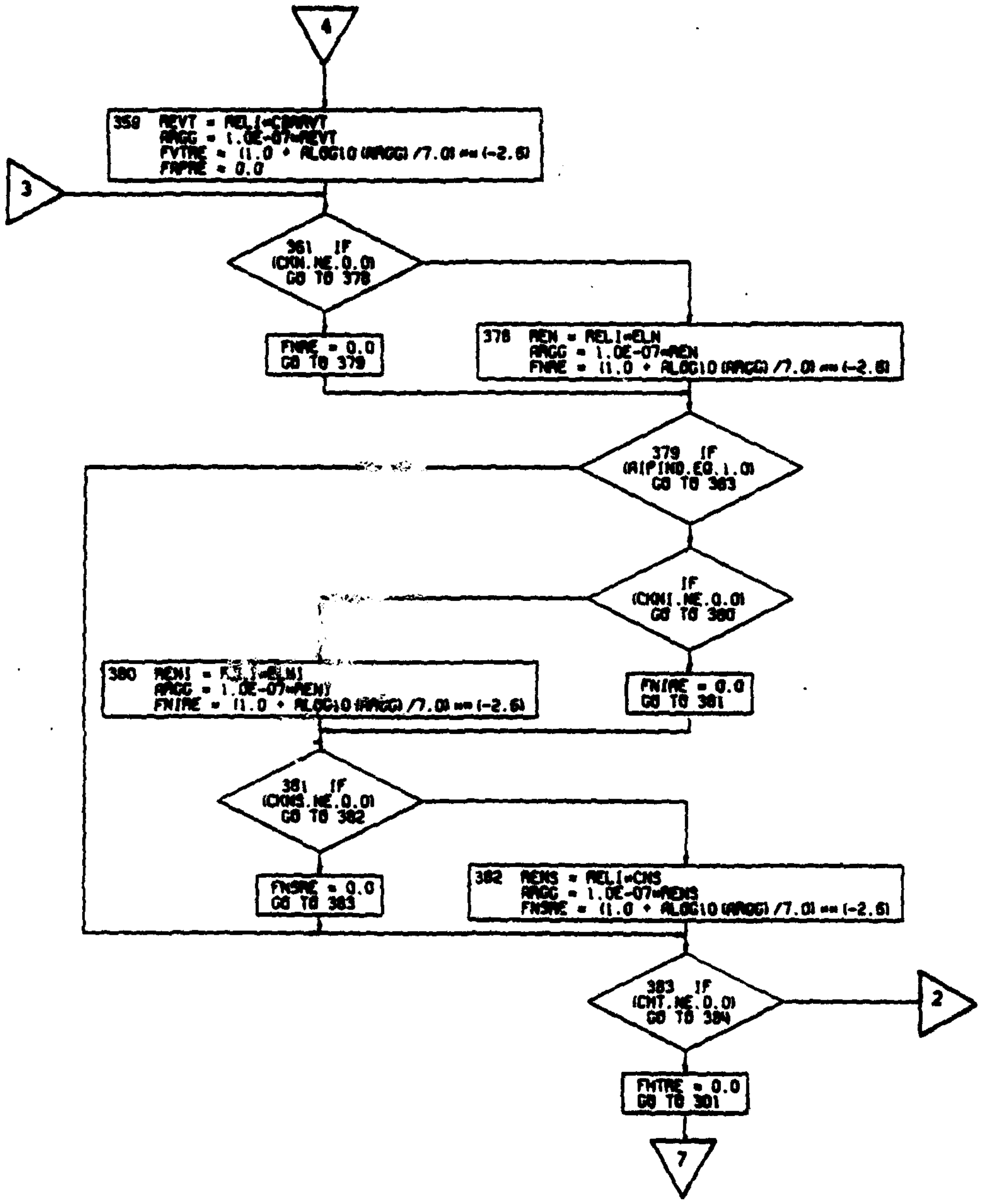


Figure 4-34. AERO Subroutine, Flow Chart (Part 2 of 4)

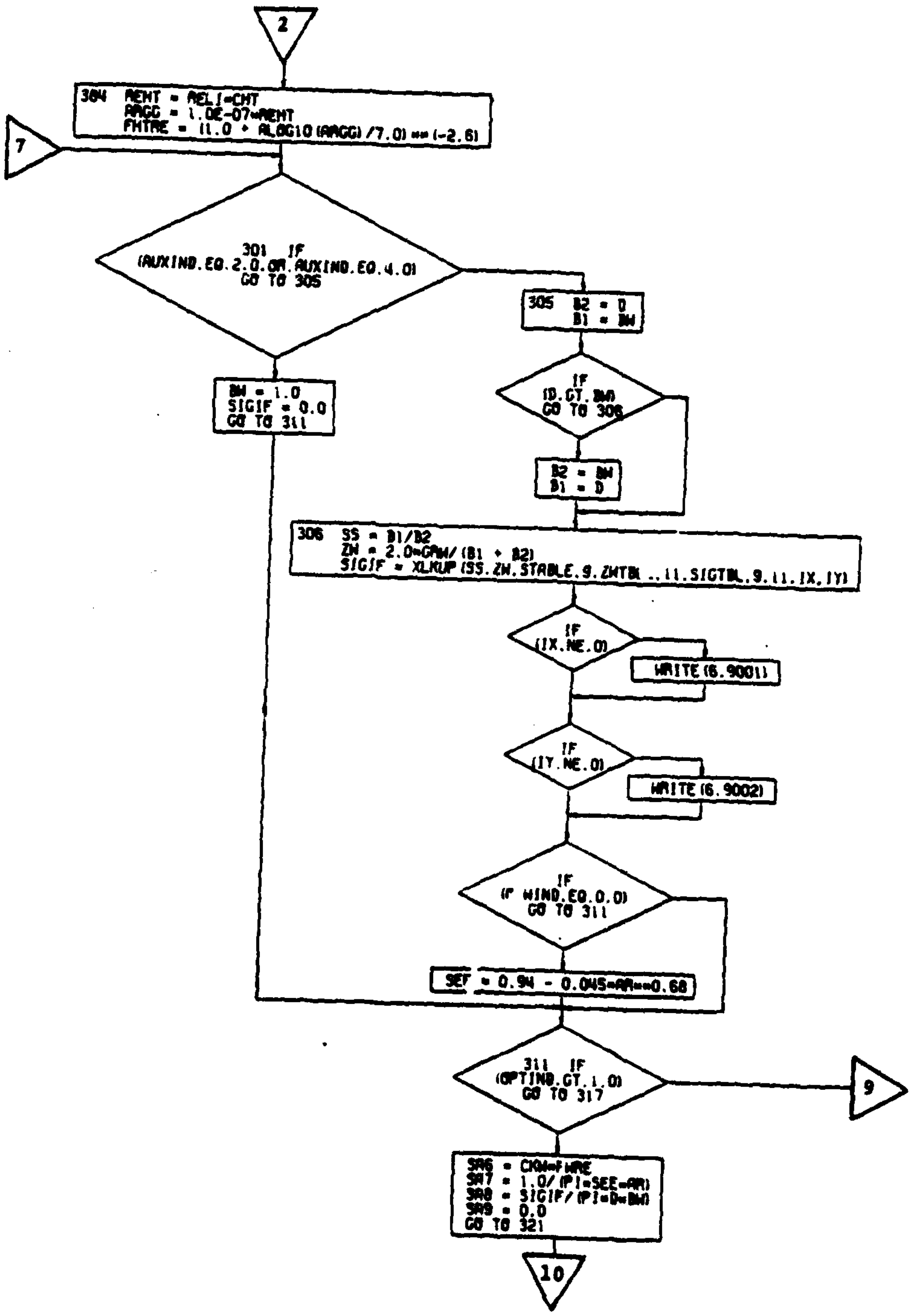


Figure 4-34. AERO Subroutine, Flow Chart (Part 3 of 4)

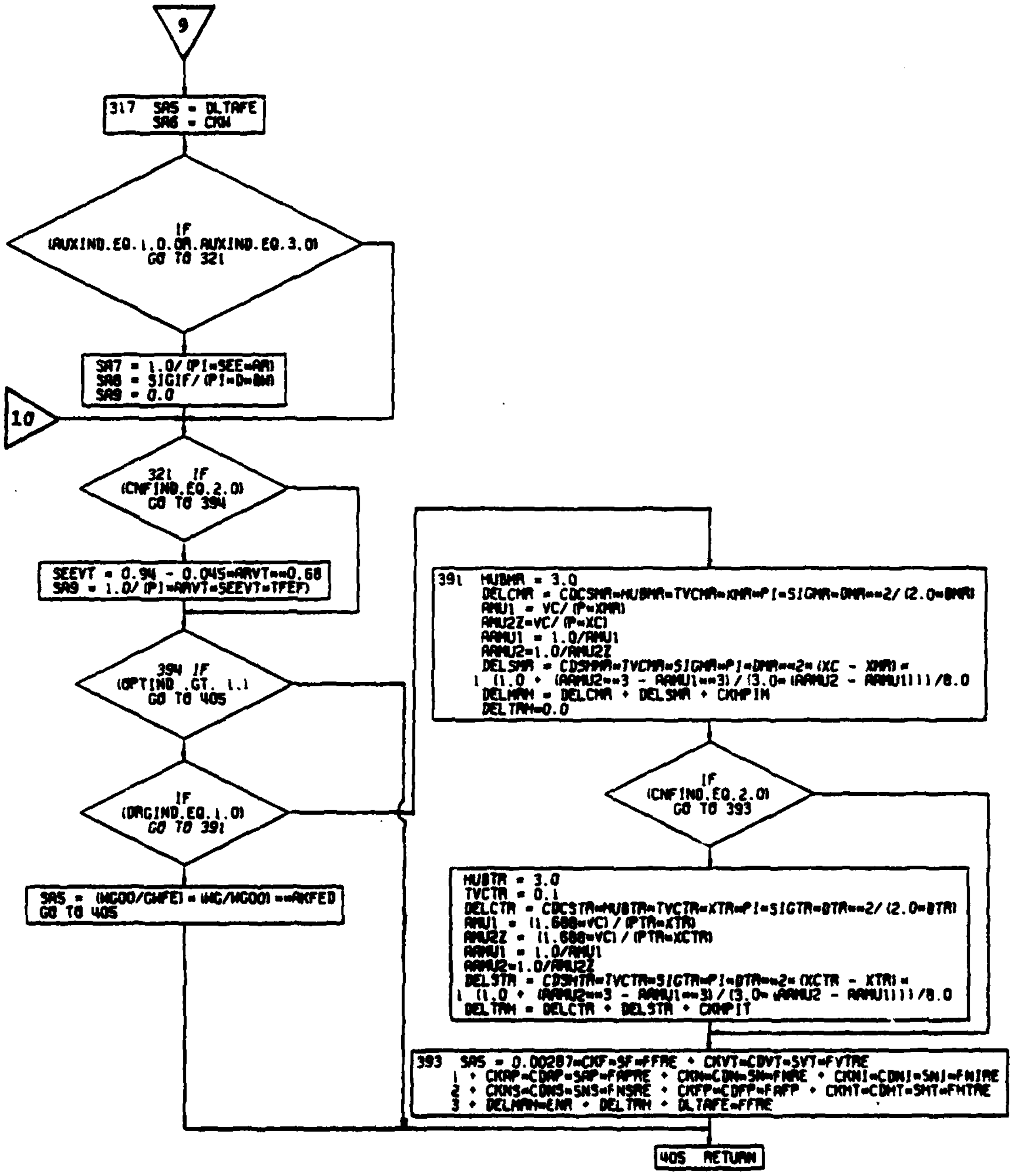


Figure 4-34. AERO Subroutine, Flow Chart (Part 4 of 4)

4.10 ENGINE SIZING SUBROUTINE

The engine cycle performance data included in the engine library consists of detailed performance maps of power (or thrust), fuel flow, N_I, and N_{II}. The data, as shown in Table 4-1, is in normalized, referred format. In particular, horsepower is normalized with respect to the value of power at the maximum static rating at sea level, standard day conditions. Thrust is similarly normalized to the maximum static thrust at sea level for standard day.

The engine sizing subroutine calculates the value of the scaling factors; namely, the maximum static thrust or power (S.L., std.). If so desired, the user may study a helicopter with fixed rather than "rubberized" primary engines. This is accomplished by means of the indicator FIXIND. If FIXIND = 0, the user inputs the maximum (installed) power of the primary engines. If FIXIND = 1, the engine sizing subroutine calculates the installed power.

A variety of different criteria are often applied to determine engine size requirements. These criteria, differing as they do, can generally be related by a single factor. For a takeoff condition this factor is the value of equivalent required thrust-to-weight ratio. Similarly, engine sizing requirements for forward flight can be related to a set of cruise conditions; namely, cruise altitude and true airspeed.

Engine sizing requirements for helicopters are generally set by takeoff conditions, and less frequently by forward flight conditions. The program, therefore, permits the user two options of calculation. The first option (ESCIND = 1) will calculate engine size for takeoff conditions only; the second option (ESCIND = 2) will calculate engine size for both takeoff and forward flight conditions, compare the two, and pick the more critical condition. The engines are sized for takeoff to provide a required (input) equivalent thrust-to-weight ratio with a specified (input) number of engines inoperative, at a specified fraction (SHP_E/SHP^*) of the maximum power the specified sizing condition.

Cruise conditions are specified by means of altitude ambient temperature, true airspeed; and in the case of a compound helicopter, the propulsive thrust split $(T_{AUX}/T_{TOT})c$, LOC 0239, between the auxiliary propulsor and the main rotor. When the engine is sized for cruise the program will accept the T_{AUX}/T_{TDT} schedule input, LOCS 1671-1692. In addition, the user may select the power setting to be used; maximum, military, or normal, input LOC 0234.

In case of a configuration having auxiliary independent cruise engines (APIND = 2), these engines may either be fixed or sized independently of the primary engines. The auxiliary independent engines can only be sized for cruise. For example, it would be possible to study a configuration with fixed size primary engines (FIXIND = 0) while sizing the auxiliary engines to meet cruise requirements. NOTE: in a case like this, input locations 0234-0241 must be filled out to allow sizing for the auxiliary engines, even though the primary engines are fixed in size.

In addition to sizing the primary and auxiliary engines, this subroutine calculates the main rotor, tail rotor (in the case of a single rotor helicopter) and auxiliary propulsion drive system rating (in the case of a compound helicopter). The options available to the user for this purpose are:

XMSNIND = 0 Main, tail and auxiliary drive system ratings specified as fraction of primary engine installed power (in the case of a compound helicopter with auxiliary independent propulsion, the auxiliary independent drive system rating is specified as a fraction of the auxiliary independent engine installed power).

XMSNIND = 1 The drive system ratings calculated are equal to the product of the applicable multiplicative factors (SHP_{MRX}/SHP^*MR, SHP_{TRX}/SHP^*_{TRP}, SHP_{AUX}/SHP^*_{AUX}) and the component (main tail, and auxiliary) power obtained from the proportional split (based on power required) of the total sea level standard maximum (installed) engine power. NOTE: IF FIXIND = 0, user must input proper power split between main rotor and tail rotor.

$$SHP_{MRX} = \left(\frac{SHP_{MXR}}{SHP^*_{MR}}\right)\left(\frac{SHP^*_{MR}}{SHP^*}\right) SHP^*$$

$$SHP_{TRX} = \left(\frac{SHP_{TXR}}{SHP^*_{TR}}\right)\left(\frac{SHP^*_{MR}}{SHP^*}\right) SHP^*$$

XMSNIND = 2 Main, tail, and auxiliary drive system ratings specified at fraction of power required to hover or cruise at design conditions (more critical of the two conditions is selected).

XMSNIND = 3 Same as 2, except the most critical of the two design conditions is compared to the drive system rating required at an alternate payload/gross weight hover at the design point conditions. The most critical of these three conditions is selected.

XMSNIND = 4 Same as 2, except that tail rotor drive system rating is selected independently of the main rotor drive system to match a specified fraction of power required to hover or cruise at design conditions (more critical of the two conditions is selected).

XMSNIND = 5 Same as 3, except that the tail rotor drive system rating is selected independently of the main rotor drive system as in 4, and the most critical of the two design conditions is compared to the tail rotor drive system rating required at an alternate payload/gross weight hover at the design point conditions. The most critical of these three conditions is selected.

It should be noted that when FIXIND = 0 or FIXINDI = 0; i.e., fixed size engines, any of the six transmission sizing options (XMSNIND = 0 - 5) may be used. If drive system ratings calculated based on meeting specified flight conditions (XMSNIND = 2 - 5) exceed the installed power rating of the fixed size engines, the drive system ratings are reset to "match" the fixed size engines.

The use of separate engine and transmission sizing options provides great flexibility in meeting conflicting engine/drive system requirements. For example, using XMSNIND = 2, it is possible to size a helicopter's primary engines to meet an engine inoperative in hover requirement, while only rating the drive system for the actual power required to hover at that design point, thus effecting a considerable saving in drive system weight. Or, using XMSNIND = 3, it is possible to rate the drive system for the power required at an alternate gross weight/payload hover point, while still meeting the original engine out sizing criteria. Note that XMSNIND = 4, 5 are of use only when sizing single rotor helicopters (CNFIND = 1.0).

The drive system ratings determined in the sizing process may be used to limit helicopter performance by setting Q_{IND} (LOC 1205) = 1, 2. The first option, Q_{IND} = 1, imposes a torque limit on the main and tail rotor transmission. The second option, Q_{IND} = 2, imposes a torque limit on the auxiliary propulsion transmission. Q_{IND} = 2 is only used with AUX_{IND} (LOC 0006)   2.0 and M_{PIND} (LOC 0253) = 0.0, and AIPIND (LOC 0012) = 1.0.

Note that when OPTIND (LOC 0001) = 0, 1 and Q_{IND} (LOC 1205) = 1, 2, QMAX/Q* (LOC 1224) must be set = $\dfrac{1}{N_{IIMAX}/N_{II}{}^{*}}$

When OPTIND = 2, 3 and Q_{IND} = 1, the main transmission rating input LOC 1224 $\dfrac{Q_{MAX}}{Q^{*}} = \dfrac{\text{SHP rating}}{\text{SHP}^{*}}$

If OPTIND = 2, 3 and Q_{IND} = 2, the main transmission rating is the same as Q_{IND} = 1, however the auxiliary propulsion transmission rating is input as

$$\frac{SHP_{AUX}}{SHP^{*}_{AUX}} = \frac{SHP_{AUX\ PROP\ RATING}}{SHP^{*}} \qquad \text{where,}$$

$\dfrac{SHP_{AUX}}{SHP^{*}_{MX}}$ IS INPUT LOC 0226.

The auxiliary drive system rating is input in a similar manner as the primary drive system. There are only 2 options for torque limit, input as Q_{INDI} (LOC 2205) = 0, 1. If Q_{INDI} = 1, Q_{MAX}/Q^{*} (LOC 2224) must be set = $\dfrac{1}{N_{II_{MAX}}/N_{II}{}^{*}}$.

Helicopter performance transmission limits are applied in the power available subroutines, Figures 4-5 through 4-12.

Figure 4-35 contains a flow chart of the engine sizing subroutine.

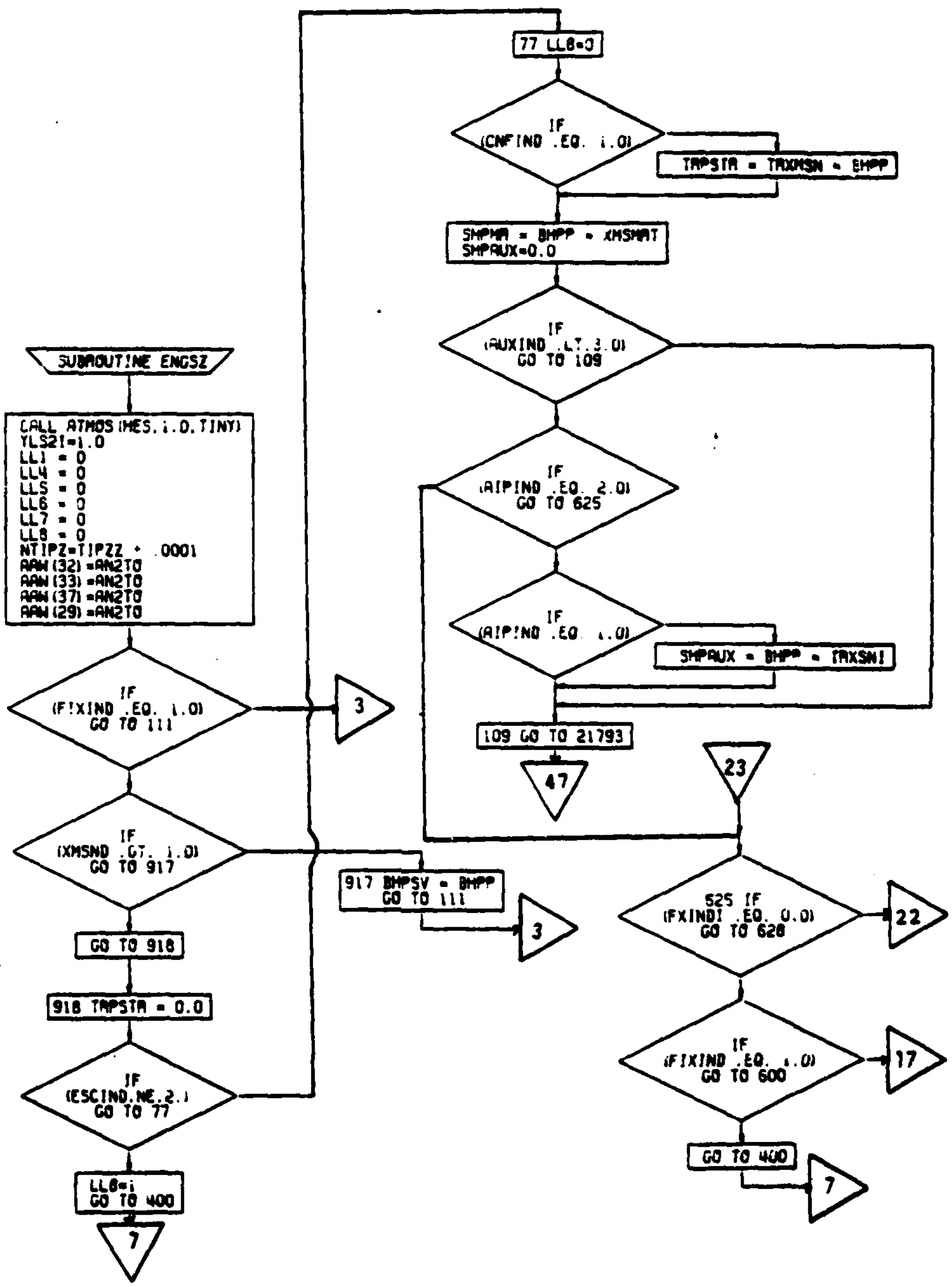


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 1 of 13)

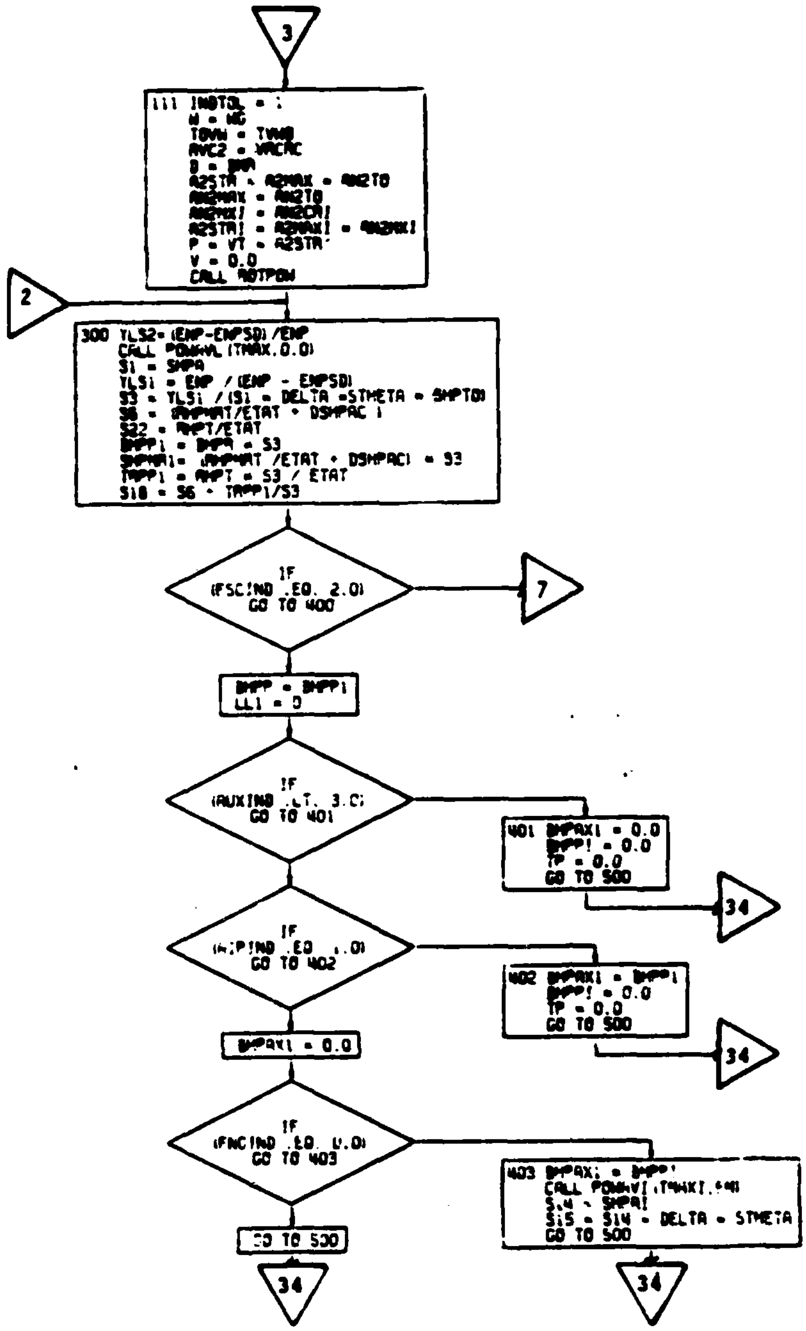


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 2 of 13)

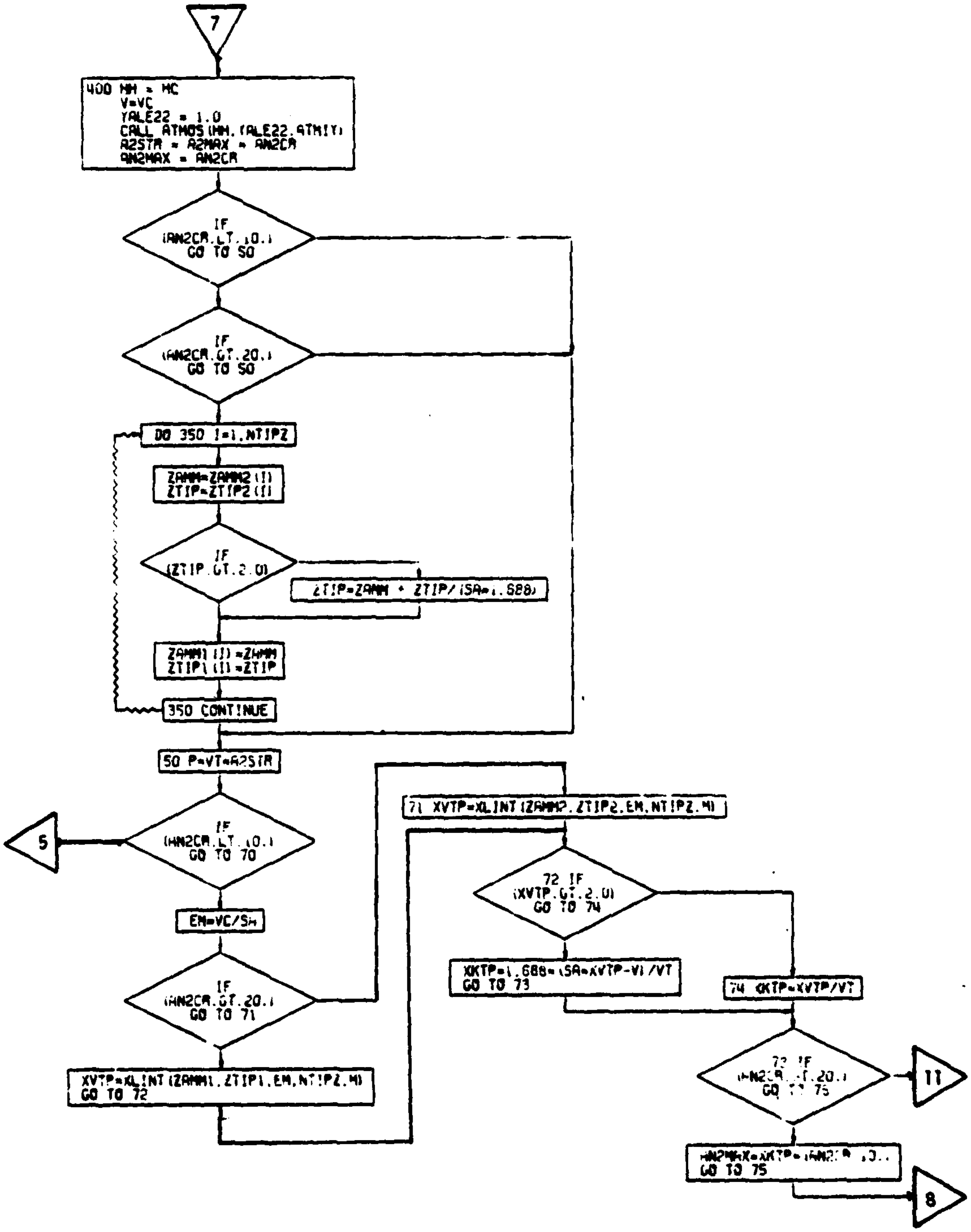


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 3 of 13)

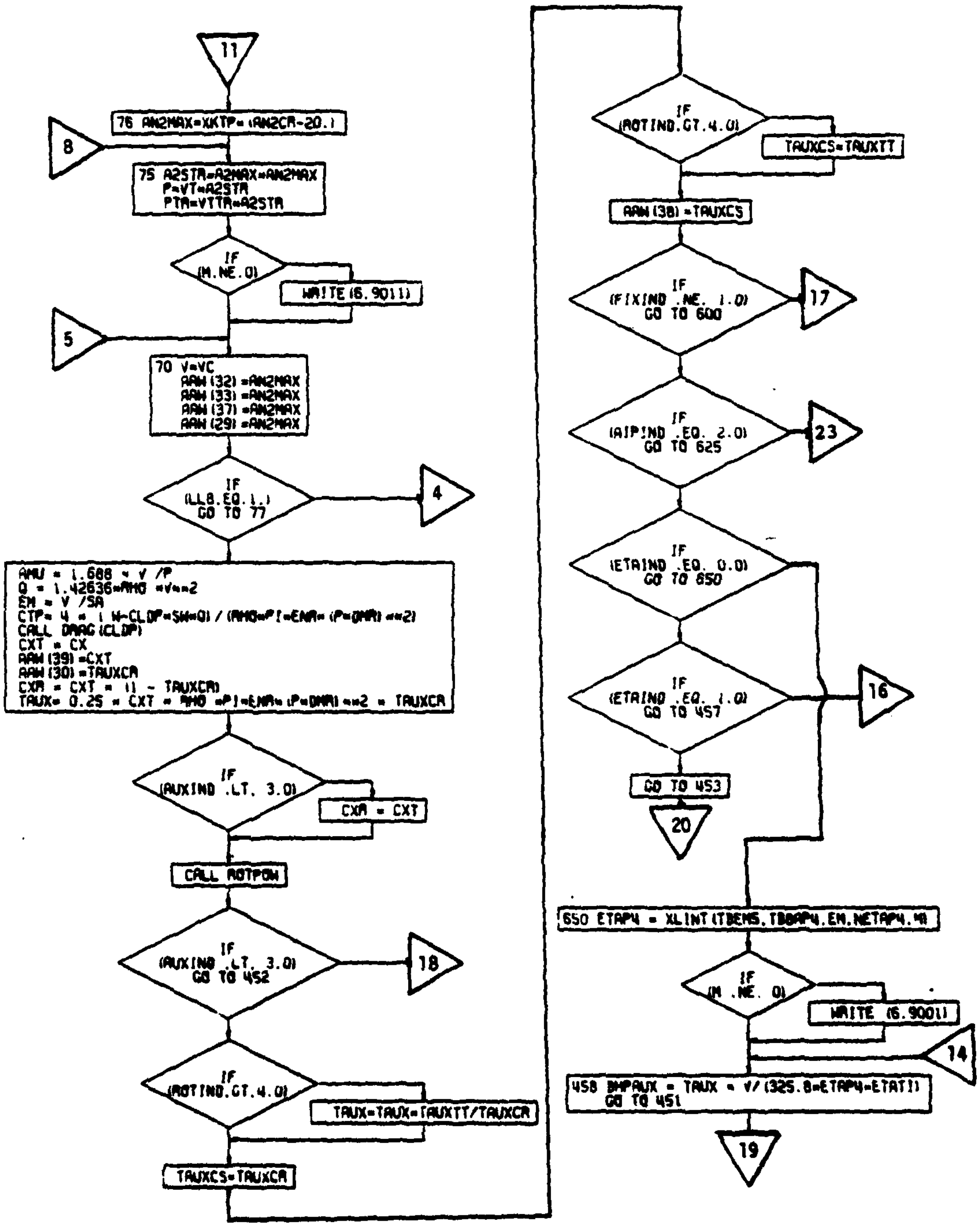


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 4 fo 13)

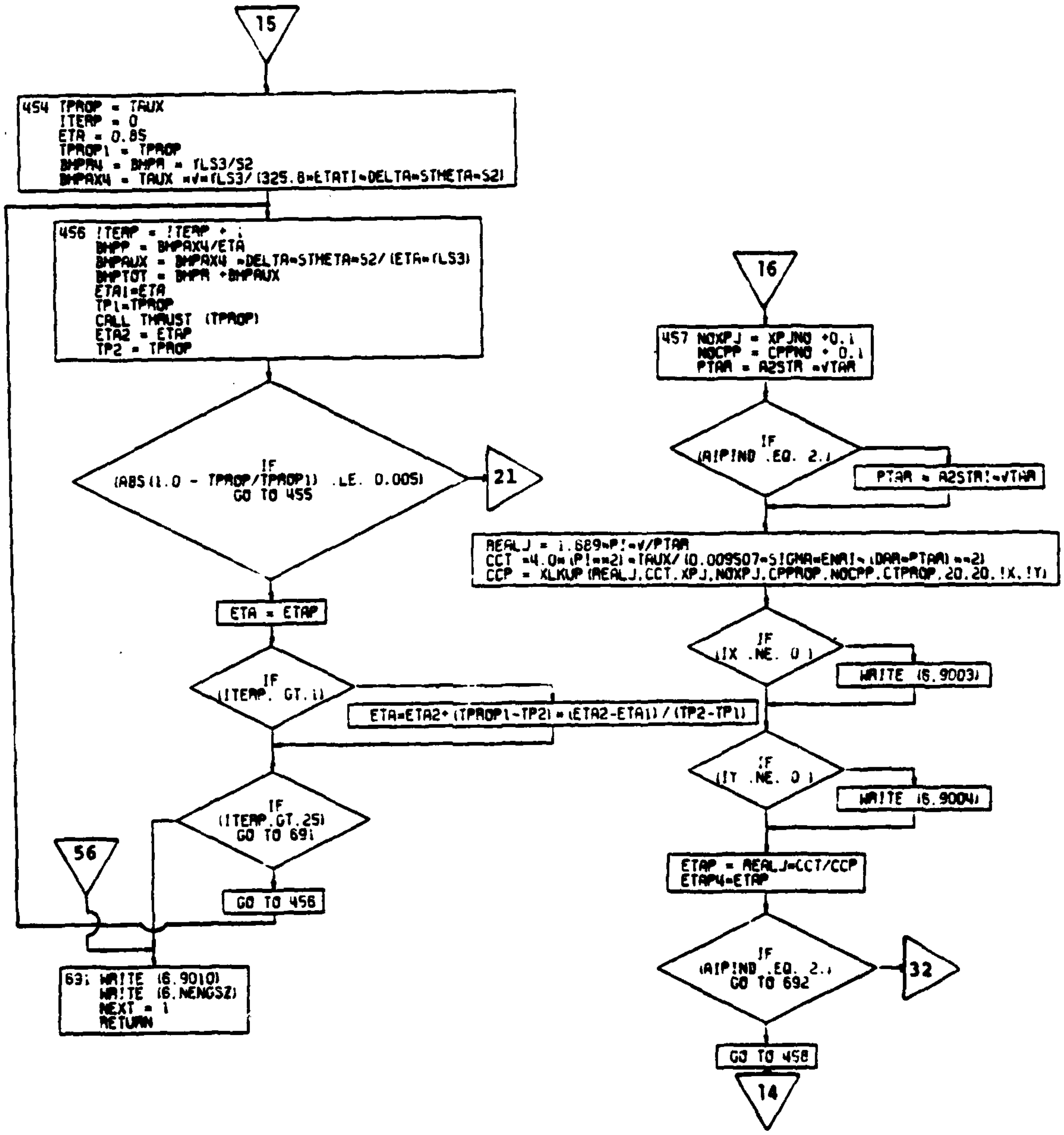


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 5 of 13)

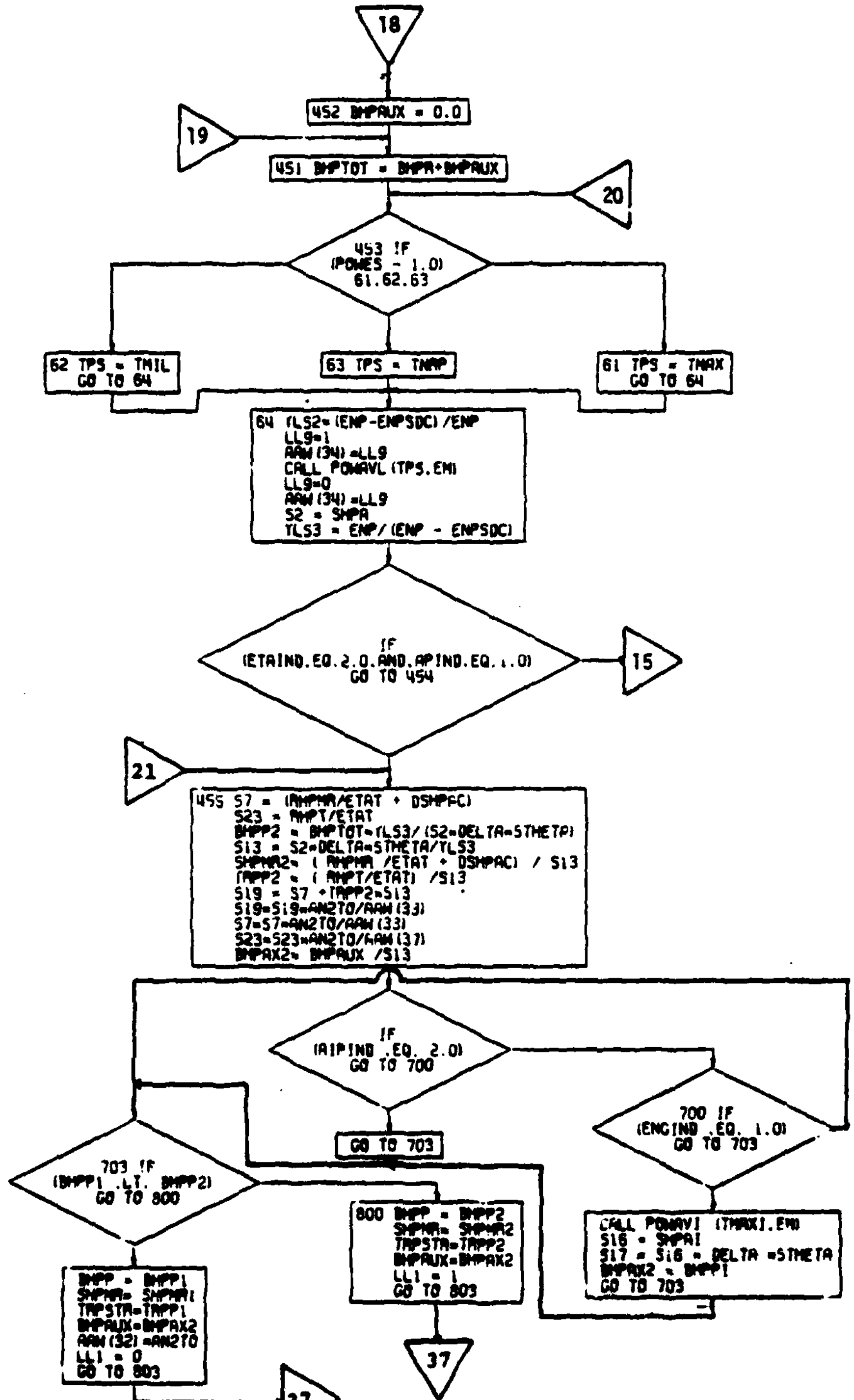


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 6 of 13)

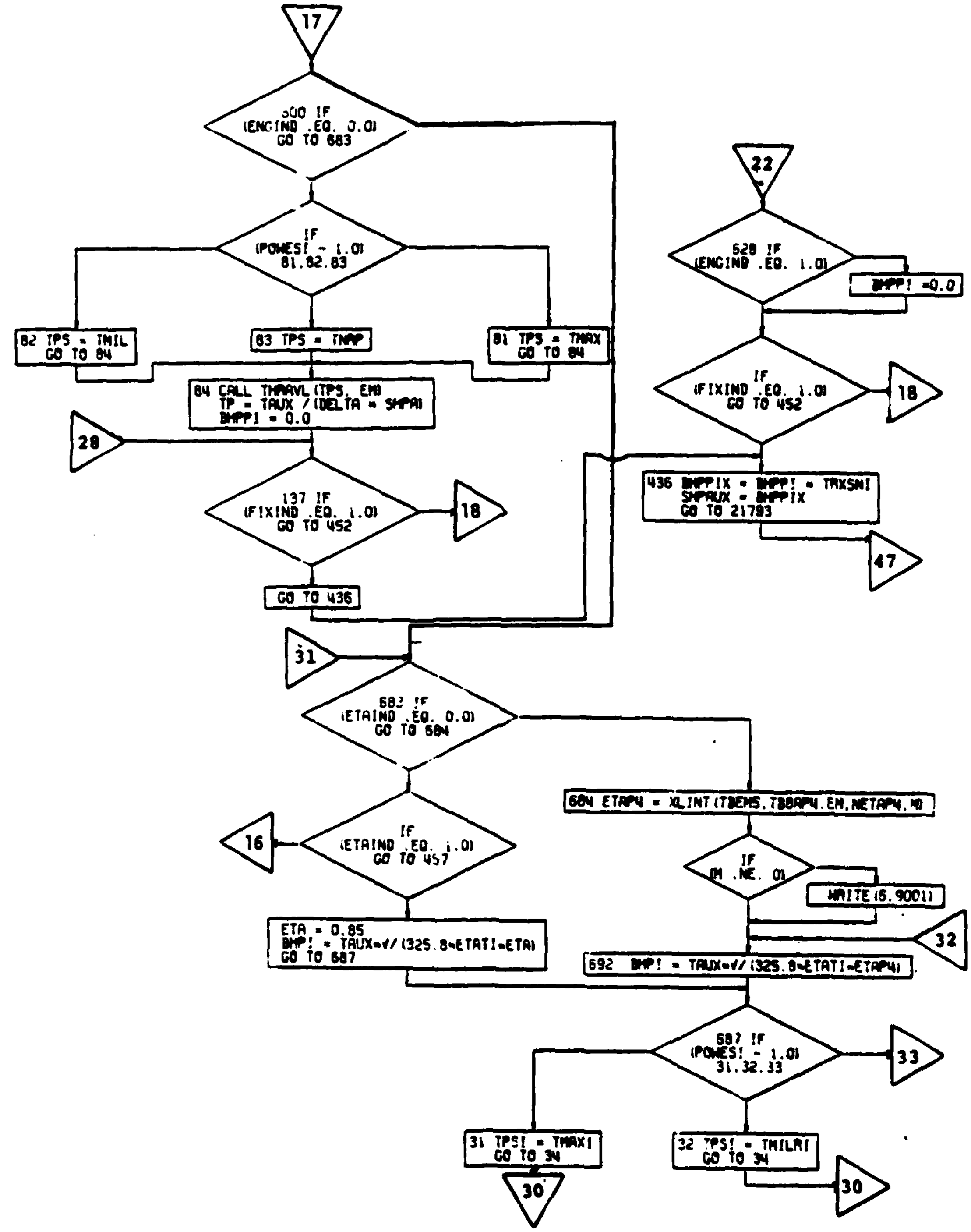


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 7 of 13)

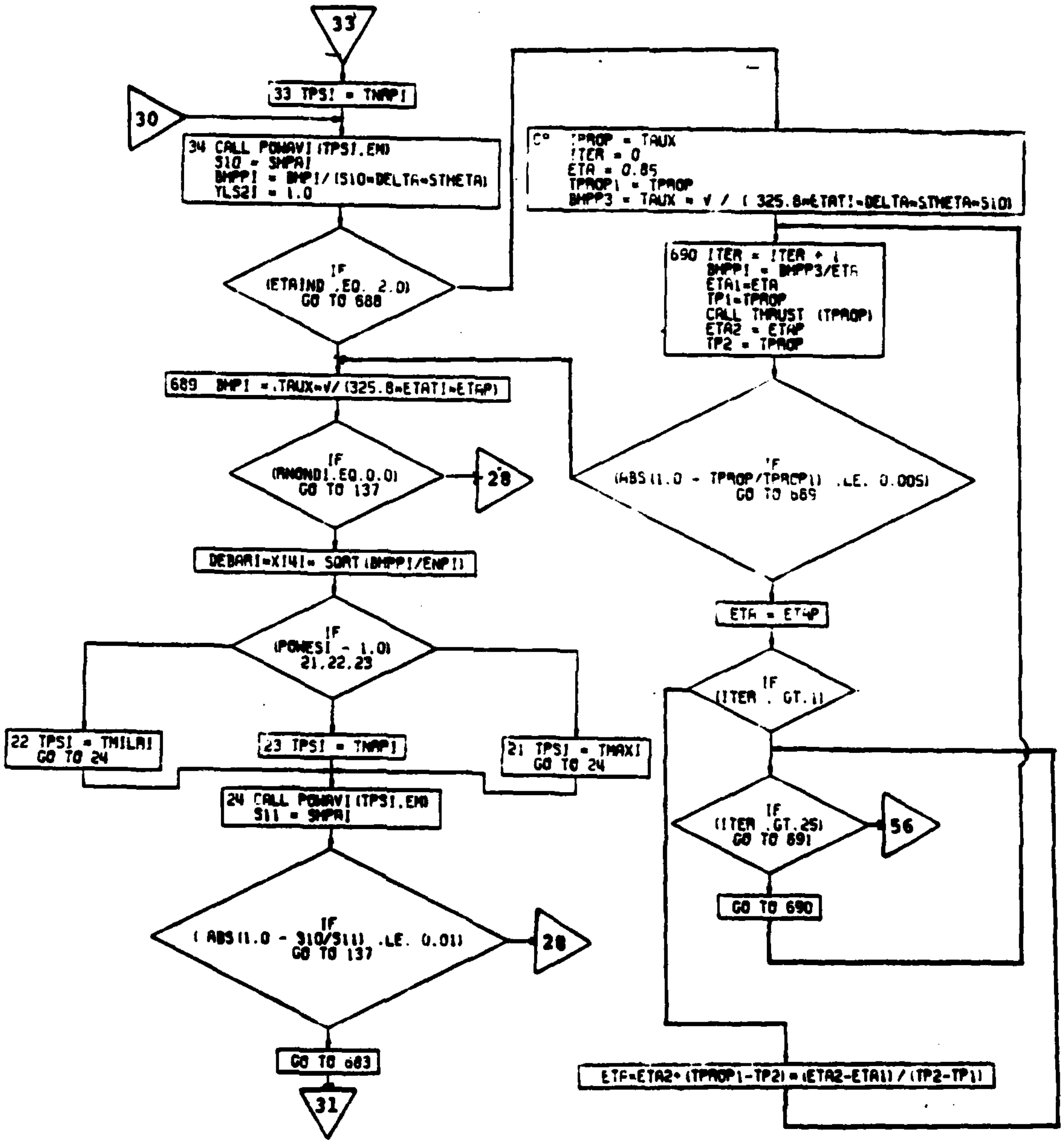


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 8 of 13)

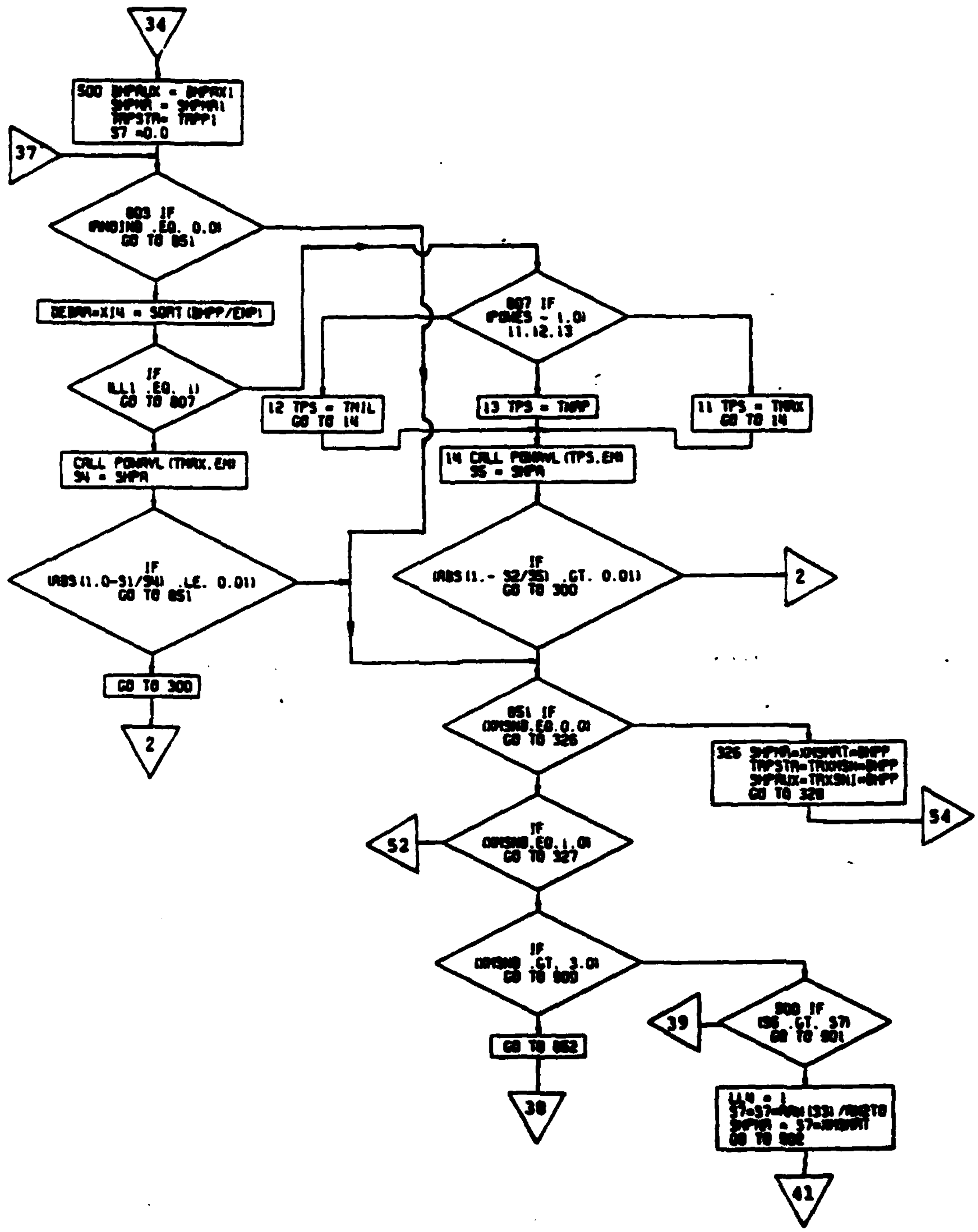


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 9 of 13)

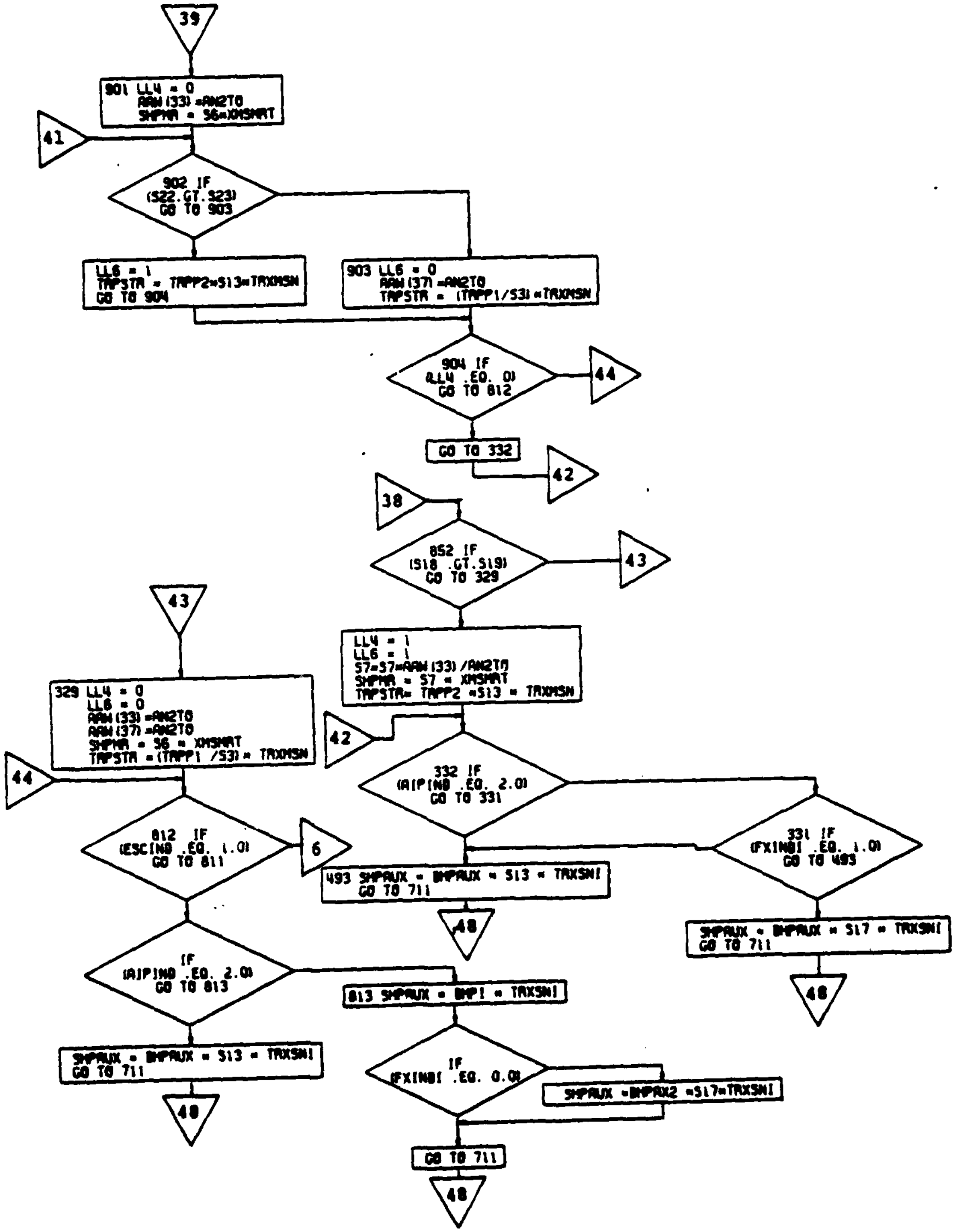


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 10 of 13)

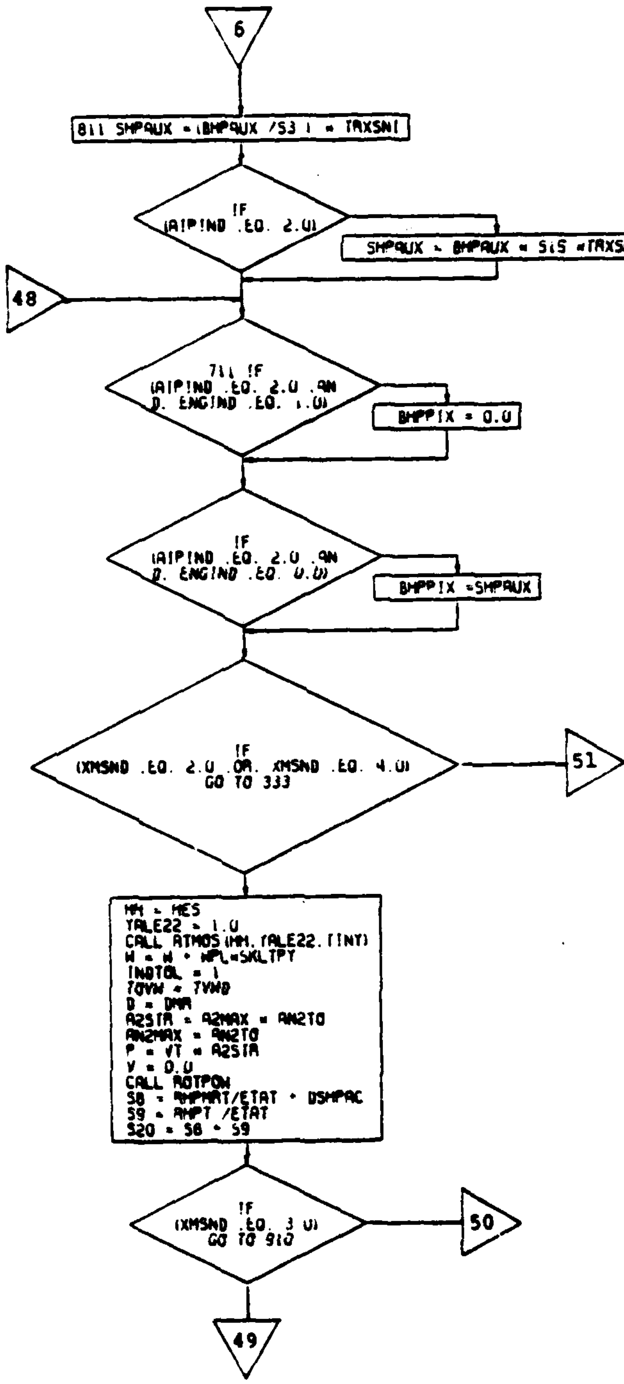


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 11 of 13)

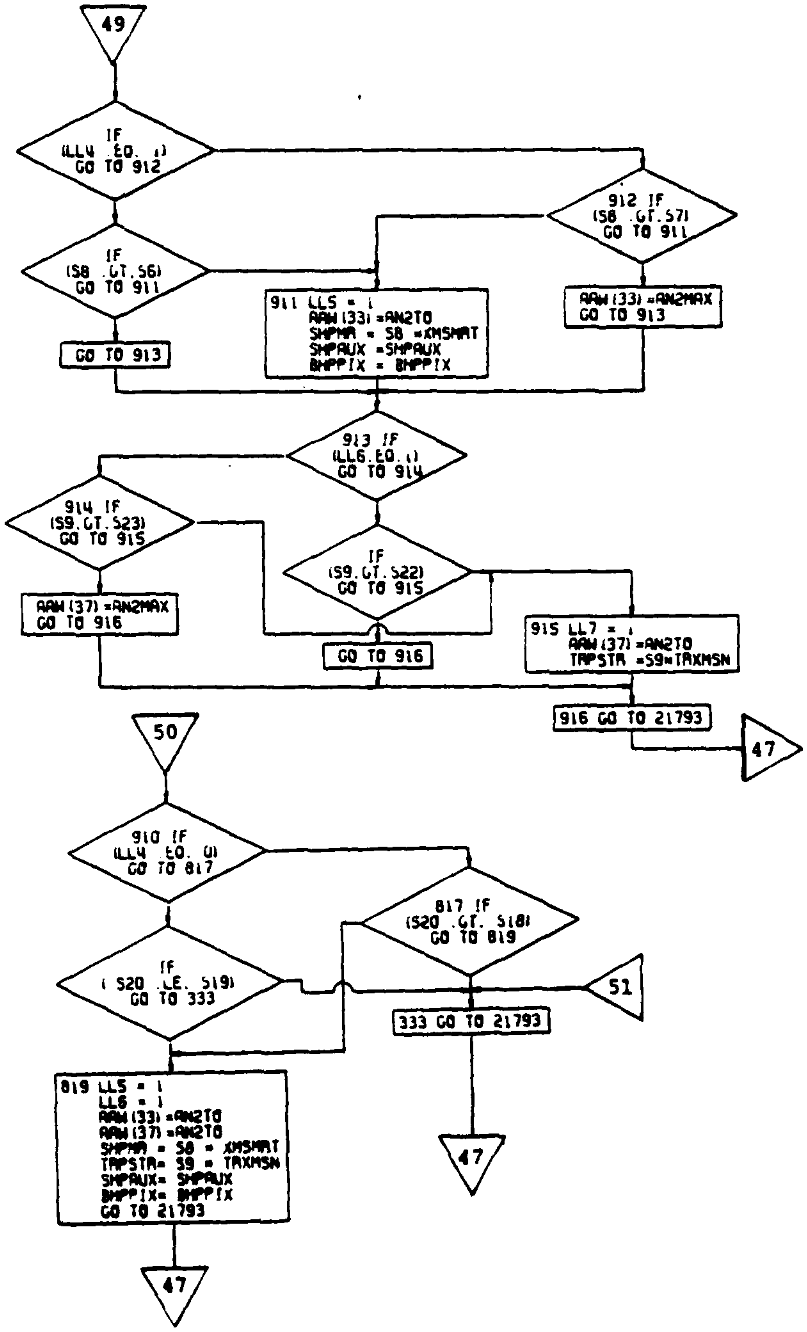


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 12 of 13)

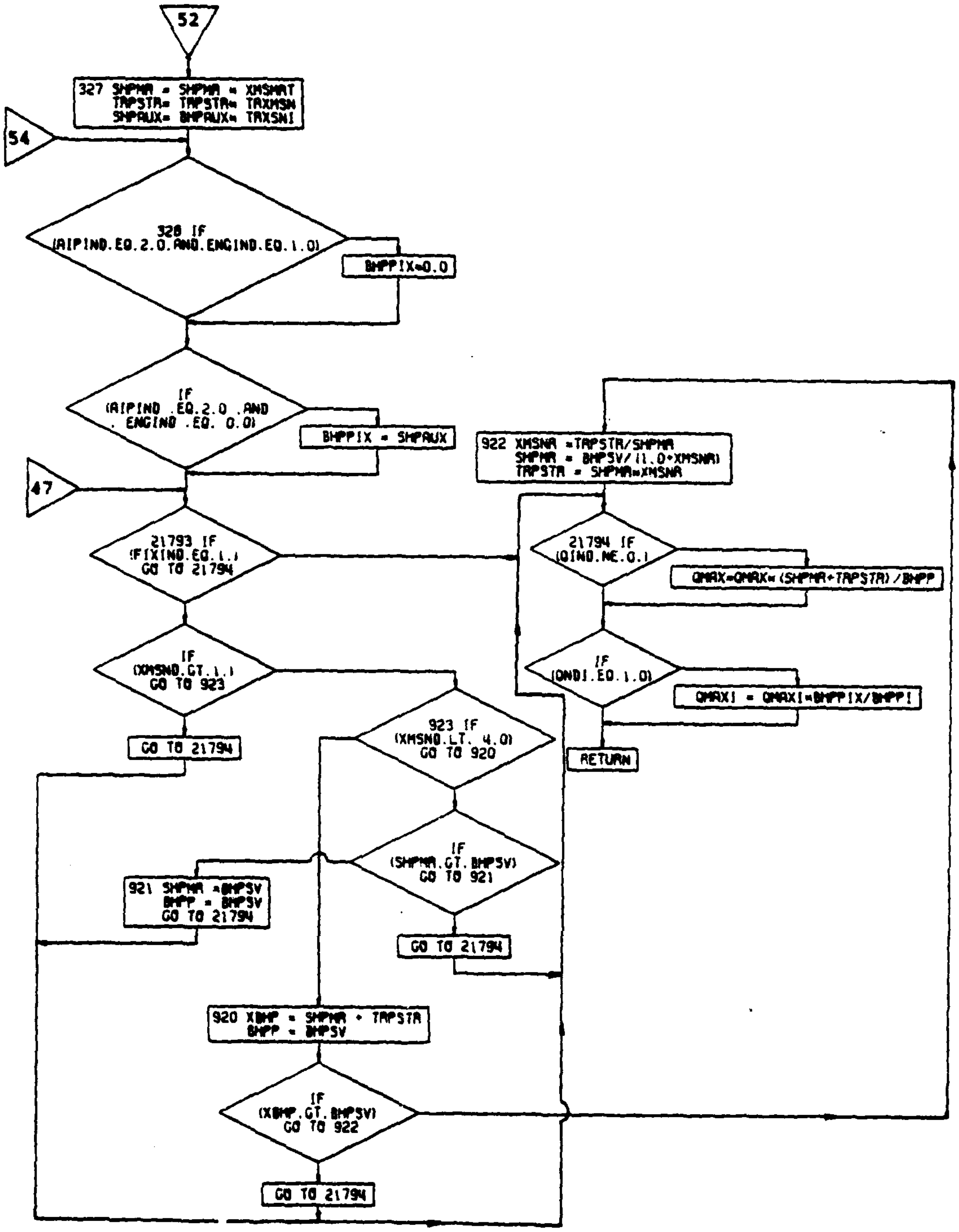


Figure 4-35. ENGSZ Subroutine, Flow Chart (Part 13 of 13)

4.11 WEIGHT TRENDS SUBROUTINE

The weight trends subroutine calculates the group weights for the propulsion system, the structures system, and the flight control system. These weights are then combined with input values of the weight of fixed useful load, fixed equipment, and payload in order to determine the weight of fuel available (Figure 4-36). The subroutine uses detailed statistical weight equations as used at the Boeing Vertol Company. The group weights are not directly added, but rather are combined by the use of incremental multiplicative and additive weight factors; these factors are useful for sensitivity studies for the aircraft. For example, if it is desired to determine the effect of an additional 300 pounds of propulsion system weight, the factor W_p is input as 300. Similarly, if it is desired to investigate the effect of a 15-percent increase in the weight of the engines, the factor K_{18} is input as 1.15.

In order to calculate the weight of the aircraft structure, the weight trends subroutine must determine the limiting design load factor. For pure and auxiliary propulsion helicopters (without wings), the program uses the input value of maneuver load factor. In the case of a wing or compound helicopter, it does this by comparing the magnitude of the input maneuver load factor with the value calculated for gust load factor. The gust load factor is evaluated at the altitude at which maximum operating equivalent airspeed (V_{MO}) is equal to the speed for maximum operating Mach number (M_{MO}) so long as the altitude falls in the band,

$$0 \leq h_{CRIT} \leq 20{,}000 \text{ ft}$$

The gust load factor is calculated at the speed V_C (see Reference 11) which is taken to be equal to V_{MO}/M_{MO}. If the user finds that his aircraft is gust-critical at other than the V_C condition, he must manually calculate the expected load factor and insert that value in the program as a dummy maneuver load factor.

4.11.1 Weight Trend Data

The weights subroutine section of HESCOMP represents one approach for determining the individual and group weights which make up the weight empty of an aircraft. The aircraft weight is divided into subgroups, as shown in Table 4-10, and is in general accordance with the weight and balance data reporting procedures and forms for Aircraft and Rotorcraft described in Military Standard 1374. A copy of Part I (Group Weight Statement) is included at the end of this section. A flow chart describing the weights subroutine is shown in Figure 4-37.

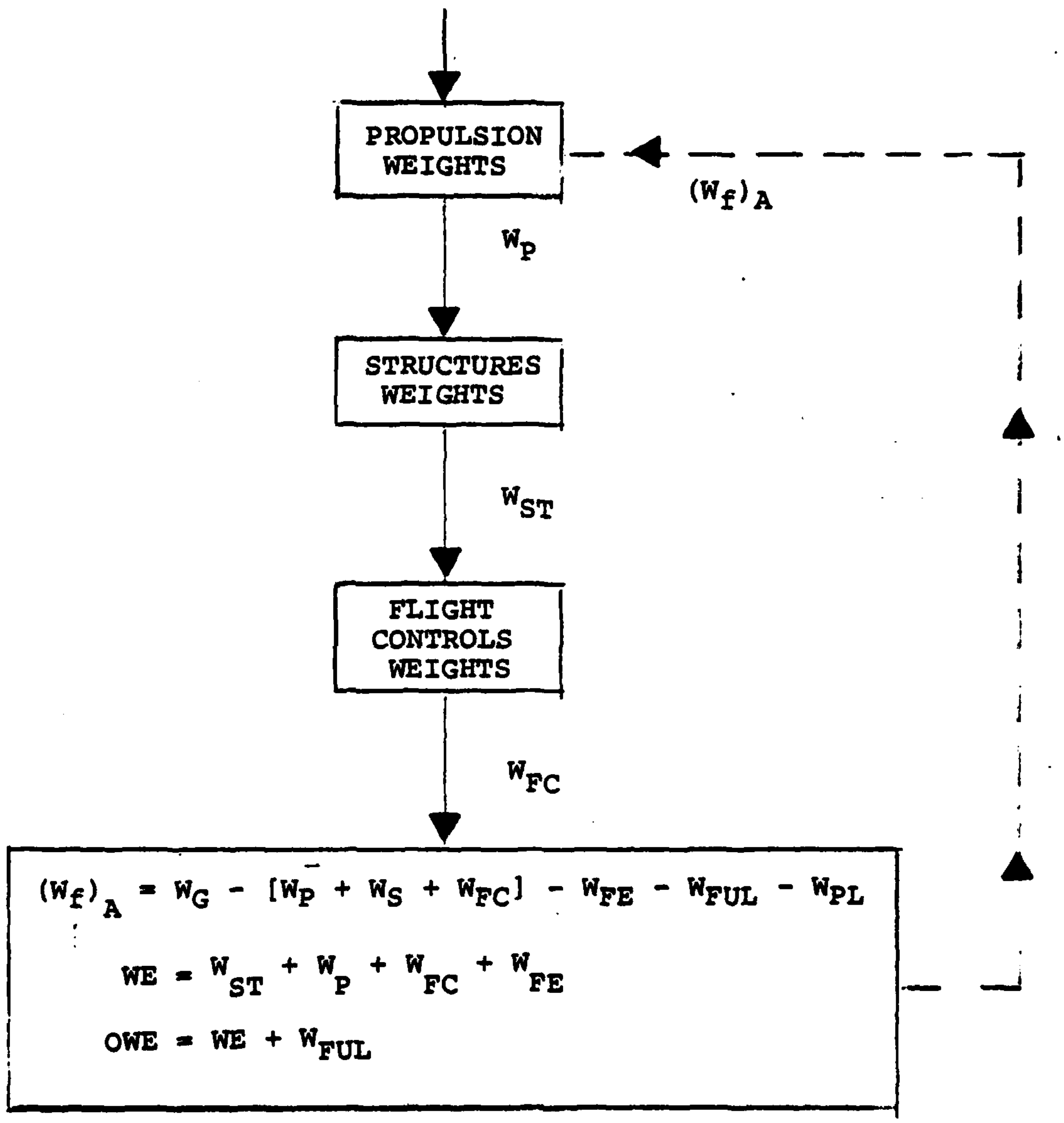


Figure 4-36. Weight Trends Subroutine.

BOEING VERTOL COMPANY

WEIGHT SUMMARY - PRELIMINARY DESIGN
(MIL-STD-1374)

TABLE 4-10. WEIGHT SUMMARY FORM

WING	1		
ROTOR	2		
TAIL	3		
SURFACES	4		
ROTOR	5		
BODY	6		
BASIC	7		
SECONDARY	8		
ALIGHTING GEAR GROUP	9		
ENGINE SECTION	10		
	11		
PROPULSION GROUP	12		
ENGINE INST'L	13		
EXHAUST SYSTEM	14		
COOLING	15		
CONTROLS	16		
STARTING	17		
PROPELLER INST'L	18		
LUBRICATING	19		
FUEL	20		
DRIVE	21		
FLIGHT CONTROLS	22		
	23		
AUX. POWER PLANT	24		
INSTRUMENTS	25		
HYDR. & PNEUMATIC	26		
ELECTRICAL GROUP	27		
AVIONICS GROUP	28		
ARMAMENT GROUP	29		
FURN. & EQUIP. GROUP	30		
ACCOM. FOR PERSON.	31		
MISC. EQUIPMENT	32		
FURNISHINGS	33		
EMERG. EQUIPMENT	34		
AIR CONDITIONING	35		
ANTI-ICING GROUP	36		
LOAD AND HANDLING GP.	37		
	38		
	39		
	40		
	41		
WEIGHT EMPTY			
CREW			
TRAPPED LIQUIDS			
ENGINE OIL			
FUEL			
GROSS WEIGHT			

REV.

FORM 26391 (2/73)

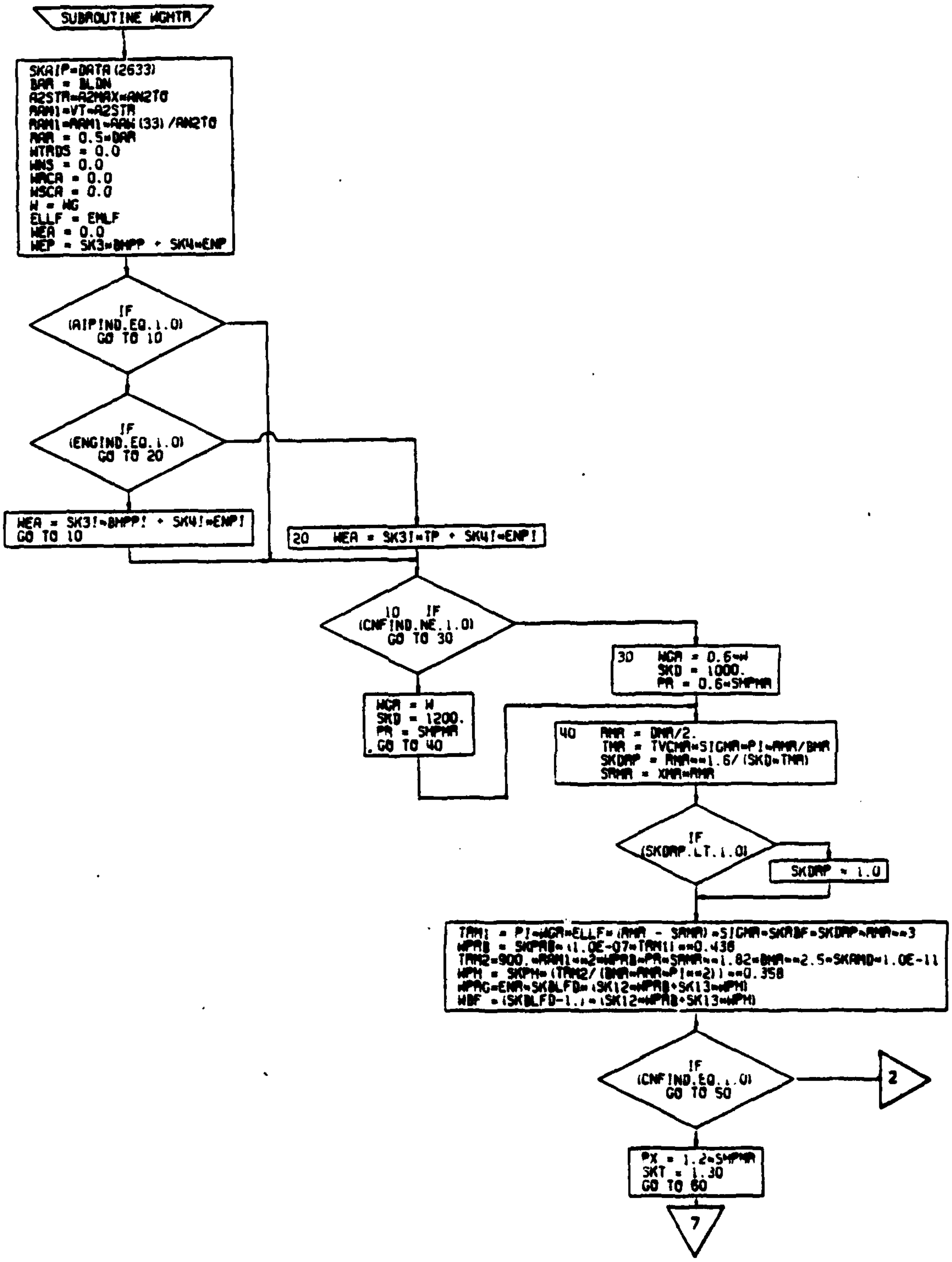


Figure 4-37. WGHTR Subroutine, Flow Chart (Part 1 of 5)

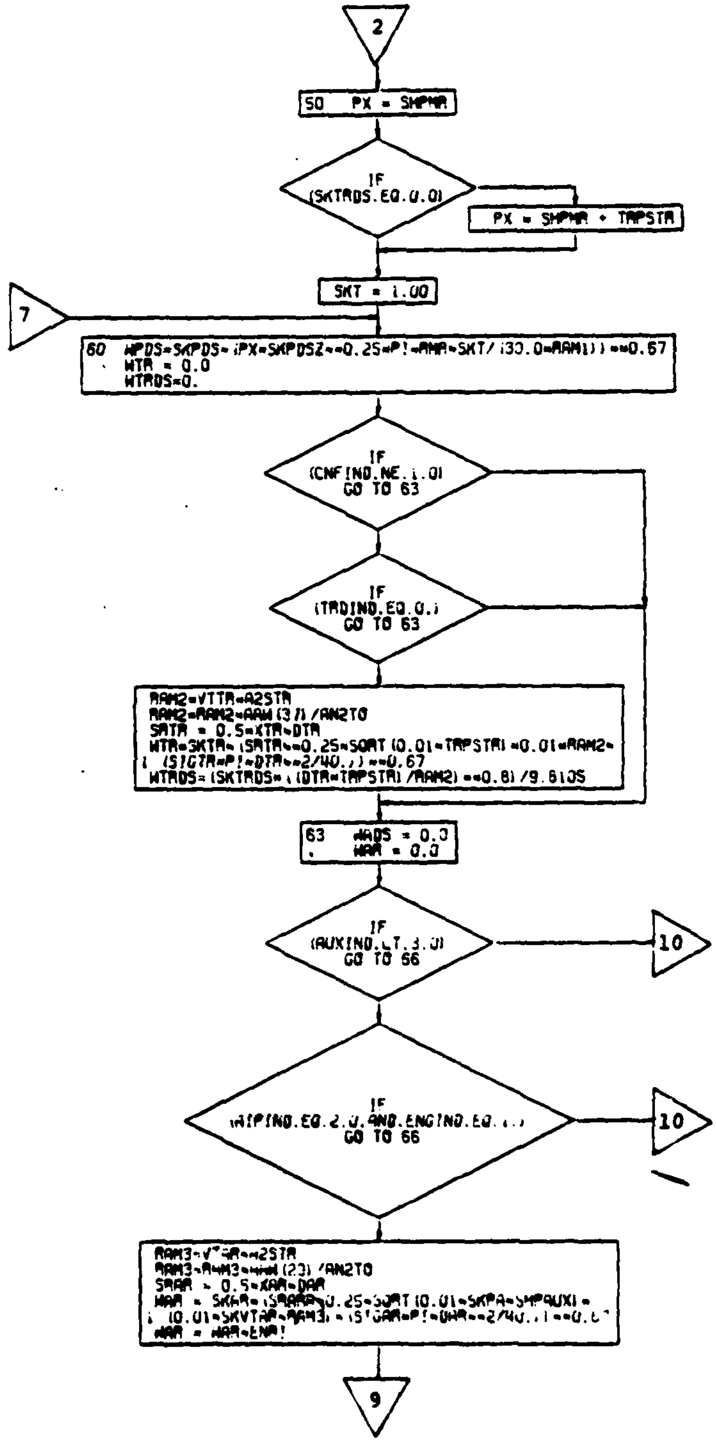


Figure 4-37. WGHTR Subroutine, Flow Chart (Part 2 of 5)

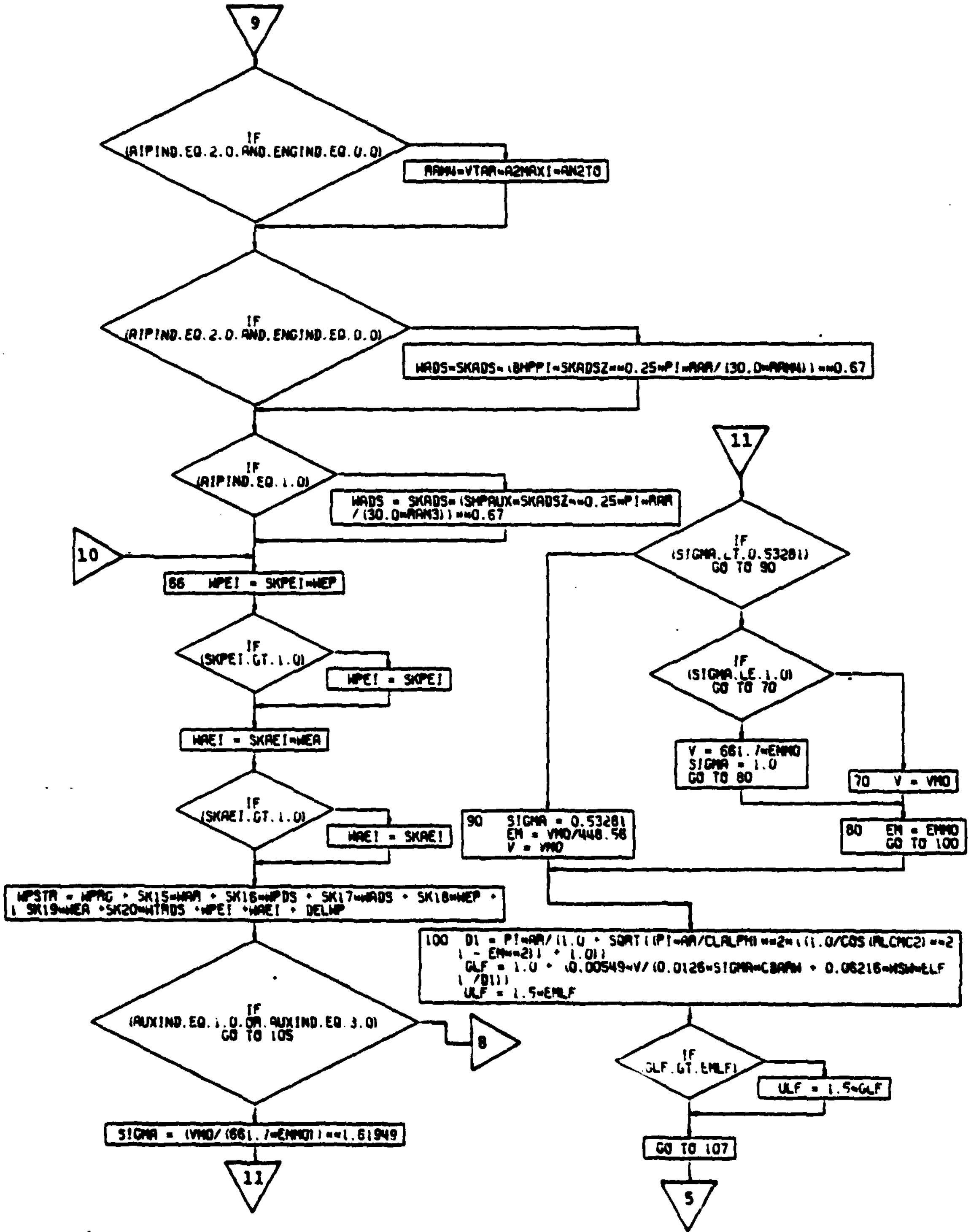


Figure 4-37. WGHTR Subroutine, Flow Chart (Part 3 of 5)

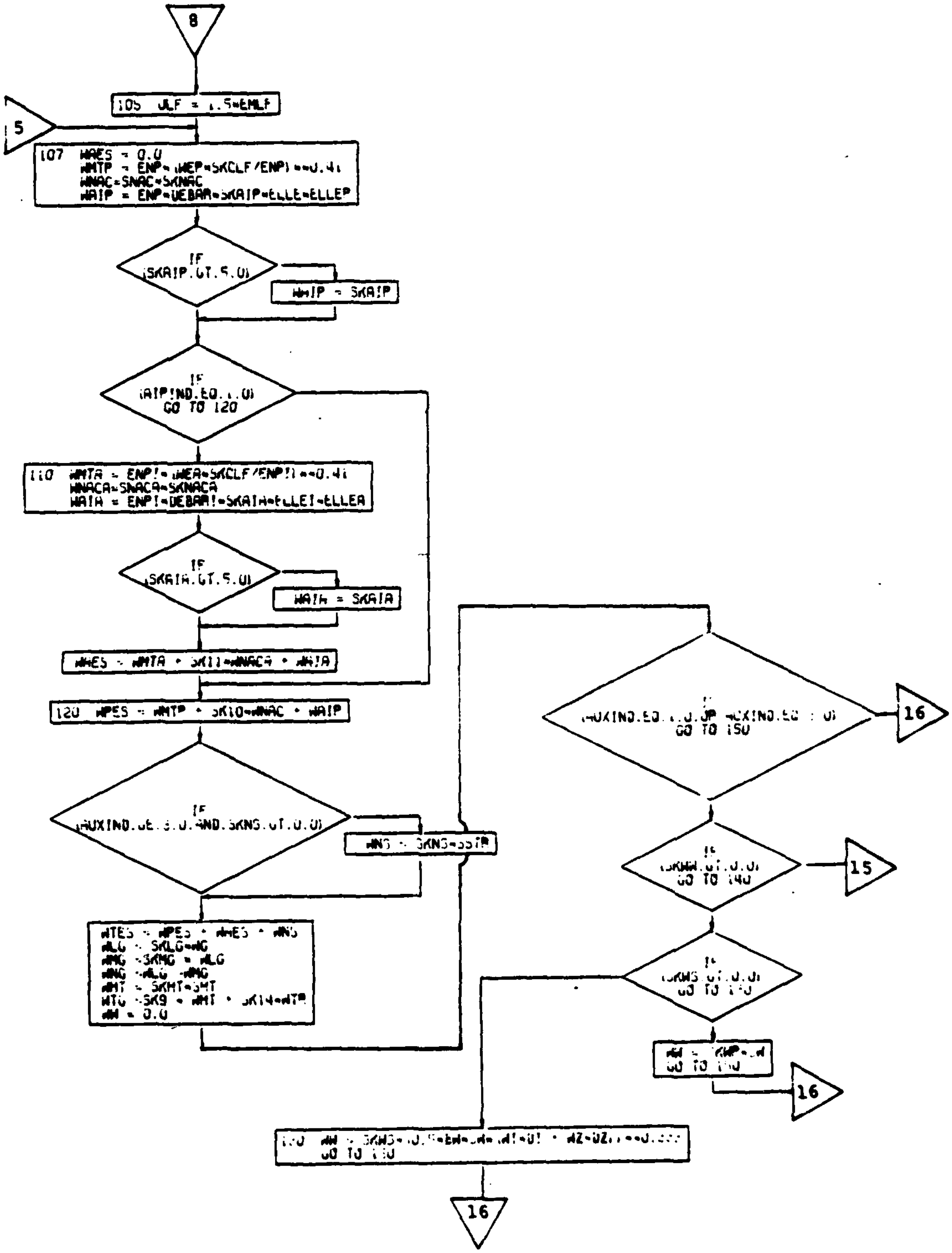


Figure 4-37. WGHTR Subroutine, Flow Chart (Part 4 of 5)

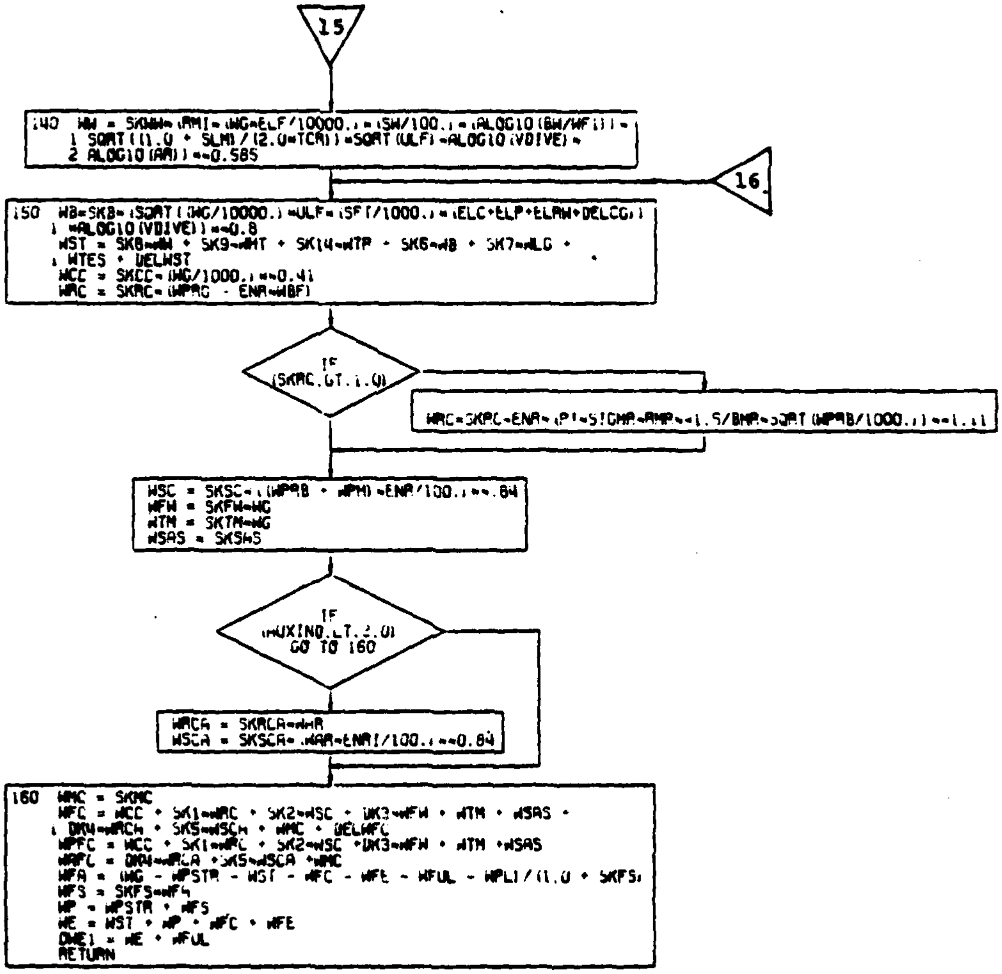


Figure 4-37. WGHTR Subroutine, Flow Chart (Part 5 of 5)

The trend equations shown on the weights subroutine flow chart and those presented in the text produce the same results, although they are not necessarily written in the same form. The flow chart equations express the text trends in the term used in other parts of the computer program.

The primary purpose of this weights subroutine is to provide a consistent method for rapidly estimating the operational weight empty and fuel available for the missions of various types of helicopters. The results obtained from the trend equations will depend largely on engineering experience and the judgment exercised in selecting the various trend constants. The weight trend equations were developed by A. H. Schmidt and R. H. Swan of Boeing Vertol Company.

An explanation of the weight trends and instructions for completing the weight input sheet are included in the text as an additional aid for filling out the weight input sheet, the page numbers defining the various k terms are included with the respective terms on the weight input sheet, Table 4-11.

Weight trends developed at Boeing were used to determine the structure weights, Table 4-10, items 1, 6, and 10; flight control weights, item 22; and the control and propulsion system weights, items 2, 5, 18 and 21. The trends were developed from existing aircraft, and use design and geometric parameters to compute the weights of the various components. For aircraft on which limited information is available, such as compound, winged and propulsive tail helicopters, the trend constants have been adjusted to account for the design features typical of the particular configuration. Alighting gear weights, item 9, are a function of the design takeoff weight and are based on statistically derived percentages of the respective gross weights. Engine weights, item 13, were determined from information compiled from engine manufacturers. Engine installation weights, items 14, 15, 16, 17 and 19, are expressed as a percentage of the dry engine weight. Fuel system weight, item 20, is determined on a pound per gallon of fuel required basis. Fixed equipment weights, items 24 through 41, are discussed in the text.

The "a" term identified as "adjustment factor" in the description of the rotor, body and drive system weight trends is a simple aid for selecting the trend slope that most closely describes the study configuration. Example: If you desire a rotor blade that compares with the criteria and design of the BO-105 rotor blade the adjustment factor "a" would be 1.1 since the BO-105 point falls midway between a = 1.0 and a = 1.20 in Figure 4-38. The value of 48.4 (44 x 1.10) would be placed in the K_{PRB} (Loc. 1537) block on the weight input sheet (Table 4-11).

Table 4-10 is representative of a typical weight summary form used for military aircraft. Weight definitions as used in MIL-STD-1374 and weight handbooks follow.

6.2.3 Weight Definitions - As used in MIL-STD-1374 and Weight Handbooks.

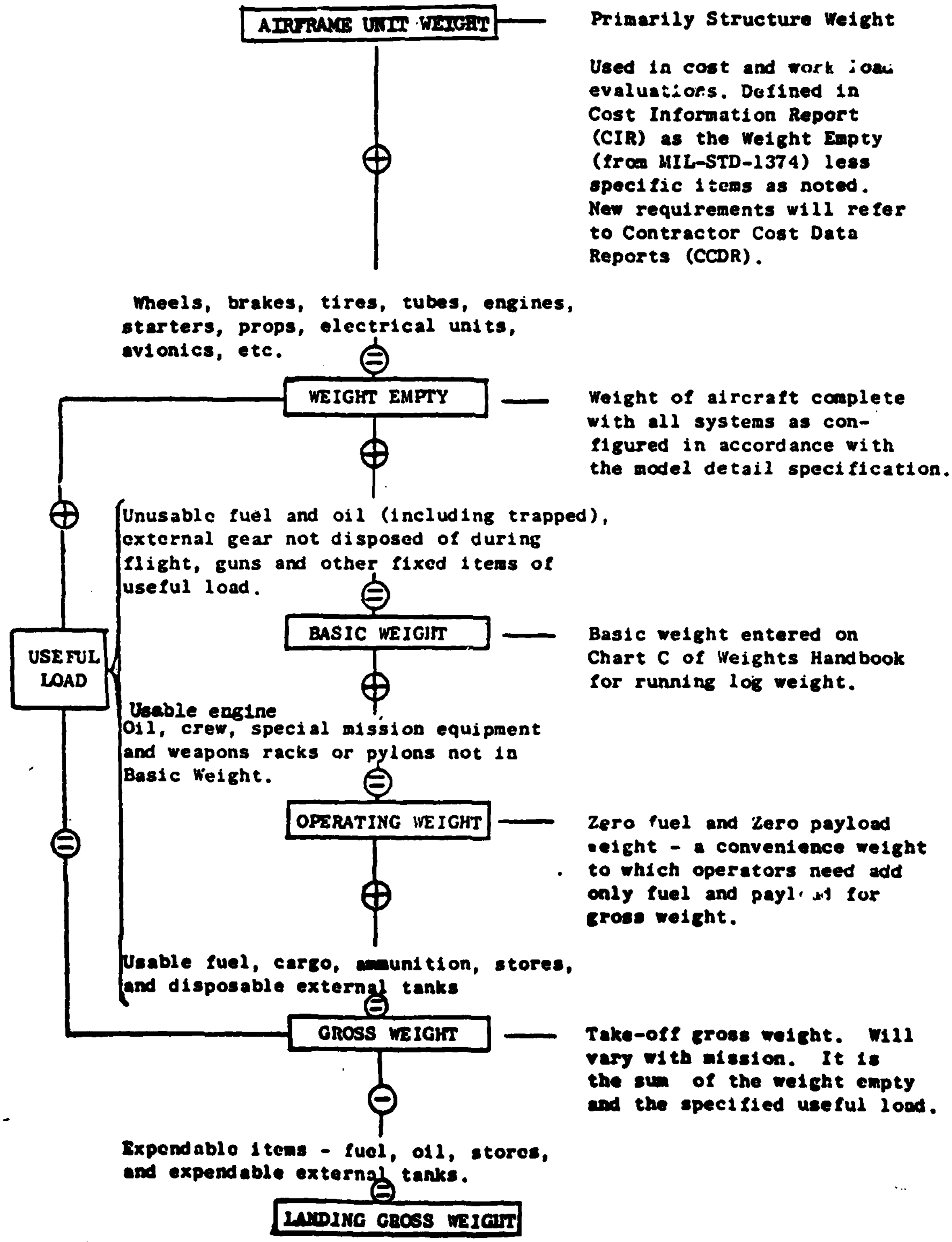


TABLE 4-11. HELICOPTER WEIGHT INFORMATION

Incremental Group Wts Nom = 0

Variable	LOC	Value*
OWE**	2601	4-174
W_{FE}	2602	4-211
W_{FUL}	2603	4-211
W_{PL}***	2604	4-214

Variable	LOC	Value*
ΔW_{FC}	2605	4-214
ΔW_{P}	2606	4-214
ΔW_{ST}	2607	4-214

Variable	LOC	Value*
RM_I	2608	4-186
W_i	2609	4-187
W_o	2610	4-187
L_i	2611	4-187
L_o	2612	4-187

Group Weight Information

Flight Controls

k_{CC}	2613	4-207
k_{RC}	2614	4-207
k_{SC}	2615	4-207
k_{FW}	2616	4-207
k_{TM}	2617	4-207
k_{SAS}	2618	4-211
k_{RCA}	2619	4-211
k_{SCA}	2620	4-211
k_{MISC}	2621	4-211

Structural

k_B	2622	4-195
Δ_{CG}	2623	4-195
k_{LG}	2624	4-197
k_{MG}	2625	4-197
k_{WW}	2626	4-186
LF	2627	4-186
k_{WS}	2628	4-187
k_{WP}	2629	4-187
k_{HT}	2630	4-192
k_{CLF}	2631	4-201
k_{NAC}	2632	4-201
k_{AIP}	2633	4-201
k_{NACA}	2634	4-201
k_{AIA}	2635	4-201
k_{NS}	2636	4-201

Propulsion

k_{PRB}	2637	4-189
k_{RBF}	2638	4-189
k_{PH}	2639	4-189
k_{amd}	2640	4-189
k_{BLDF}	2641	4-189
k_{TR}	2642	4-194
k_{AR}	2643	4-192
k_{PA}	2644	4-192
k_{VTAR}	2645	4-192
k_{PDS}	2646	4-205
k_{PDSZ}	2647	4-205
k_{TRDS}	2648	4-207
k_{ADS}	2649	4-205
k_{ADSZ}	2650	4-205
k_{FS}	2651	4-203
k_{PEI}	2652	4-202
k_{AEI}	2653	4-202

k_1	2654	4-214
k_2	2655	4-214
k_3	2656	4-214
k_4	2657	4-214
k_5	2658	4-214

k_6	2659	4-214
k_7	2660	4-214
k_8	2661	4-214
k_9	2662	4-214
k_{10}	2663	4-214
k_{11}	2664	4-214

k_{12}	2665	4-214
k_{13}	2666	4-214
k_{14}	2667	4-214
k_{15}	2668	4-214
k_{16}	2669	4-214
k_{17}	2670	4-214
k_{18}	2671	4-214
k_{19}	2672	4-214
k_{20}	2673	4-214

MULTIPLICATIVE FACTORS NOMINALLY = 1.0

*Page numbers in this document
**OWE is not necessary when OPTIND = 1,2
***W_{PL} is not necessary when OPTIND = 2

Wing

The weight of the wing is determined using one of the following three methods:

- Method I

$$W_W = 220(k)^{0.585},$$

Where

$$k = \left[R_M\right]\left[\frac{Wg\ LF}{10^4}\right]\left[\frac{Sw}{10^2}\right]\left[\log\frac{b}{B}\right]\left[\sqrt{\frac{1+\lambda}{2K}}\right]\left[\sqrt{N}\right]\left[\log_{10} V_D\right]\left[\log_{10} AR\right]$$

Legend

W_W = weight of wing - lb

R_M = wing relief as a fraction of design gross weight

W_g = design gross weight

LF = helicopter lift factor as a fraction of gross weight

S_W = planform area of wing (taken from C_L of aircraft) - ft^2

b = wingspan - ft

B = maximum fuselage width - ft

λ = taper ratio

N = ultimate load factor

V_D = dive velocity - kn

A_R = aspect ratio

k_r = wing root thickness ÷ root chord

Method I is used when a conventional aircraft wing is employed. It considers basic geometry, design criteria, and relief terms. The 220 constant represents a wing employing simple control surfaces. The 220 adjusted up or down depending on the complexity of the surface controls (200-240) must be placed in the k_{WW} location on the weight input sheet. LF, representing the wing unloading factor, due to rotor lift, and R_M a wing relief value (0.5 to 0.75) must be entered as a fraction of the design gross weight. The factors LF and R_M are nominally 1.0.

- Method II

$$W_W = 3.15(k)^{0.333}$$

Where

$$K = S_W \; (W_i L_i + W_o L_o)$$

<u>Legend</u>

W_W = weight of wing - lb

S_W = planform area of wing - ft^2

W_i = inboard wing store weight, lb/per side

W_o = outboard wing store weight, lb/per side

L_i = distance from side of fuselage to inboard store - ft

L_o = distance from side of fuselage to outboard store - ft

Method II is used when a sponson or stub type wing is used to carry stores or weapons. The trend constant 3.15 must be placed in k_{ws} of the weight input sheet. W_i and W_o must be entered in their respective locations in pounds per side. L_i and L_o must be entered as a fractional part of the wing semi-span.

- Method III

$$W_W = S_W \times PSF$$

Where

W_W = weight of wing - lb

S_W = planform area of wing - ft^2

PSF = pounds per ft^2

Method III is used when a single sponson or stub is employed. The estimated unit weight of the wing in pounds per square foot is placed in k_{wp} on the weight input sheet.

Main Rotors

The weight of the main rotor includes the combined weights of the blades and hub and hinge. The weights are derived from the following equations:

- Blades (per rotor) $W_B = 44\ a\ (k)^{0.438}$

  Where

  $$k = \left[\frac{W_g}{10^4}\right]\left[LLF\right]\left[\frac{R^2}{100}\right]\left[\frac{R-r}{10}\right]\left[b\ c\ k_b\right] \quad ; \quad \left[\frac{R}{k_d t}\right]^{1.6}$$

  NOTE: The last term is a droop factor, used only if the result is greater than 1.

- Hub and Hinge (per rotor) $W_{HH} = 61\ a\ (k)^{0.358}$

  Where

  $$k = \left[W_b\right]\left[R\right]\left[N_R\right]^2\left[P_R\right]\left[r\right]^{1.82}\left[b\right]^{2.5}\left[k_{amd}\ x10^{-11}\right]$$

Legend

W_b = blade weight per rotor (including root end fitting)-lb

a = adjustment factor

W_g = design gross weight per rotor (X 0.6 for tandem)-lb

LLF = design limit load factor at dgw

R = rotor radius-ft

r = rotation to blade attachment-ft

c = blade chord-ft

b = number of blades per rotor

t = maximum blade thickness at 25% R-ft

k_b = rotor type factor: 1.00 articulated, 2.2 hingeless or teetering

k_d = droop constant: 1000 tandem, 1200 single rotor

N_r = rotor rpm

P_r = takeoff power X (0.6 for tandem) per rotor-hp

k_{amd} = a x m x d

a = design concept: 0.53 hingeless, 1.00 other

m = material: steel = 1.00, titanium = 0.54

d = development stage: early = 1.0, developed - 0.62

In the trend equations the constants 44(blade trend) and 61 (hub and hinge trend) represent the average for the rotor weights presented in Figure 4-38 and 4-39. The blade weights are most representative of the all metal blades. The adjustment factor a is used to adjust the k factor when special design features are considered, such as high modulus materials (boron, graphite, etc.) or special features associated with the hub and/or hinge. Refer to Figures 4-38 and 4-39 to select the a term which most closely approximates the configuration being analyzed. The revised constants 44a and 61a must be placed in the k_{PRB} and k_{PH} locations on the weight input sheet along with the factors k_{RBF} (k_b in legend) and k_{amd}. If blade folding is required the k_{BLFD} block on the input sheet must also be filled in. Blade folding is entered as a fractional part of the total rotor weight. The blade fold penalty usually runs between 1.15 to 1.25 of the rotor weight depending on the folding requirements. The nominal value for k_{BLFD} is 1.0.

Auxiliary Rotors or Propellers

When auxiliary rotors or propellers are required, as in the case of compounds or propulsive tail helicopters, the following rotor/propeller equation is used:

$$W_R = 14.2\ a\ (k)^{0.67},$$

Where

$$k = \left[r\right]^{0.25} \left[\frac{Hpr}{100}\right]^{0.5} \left[\frac{Vtl}{100}\right] \left[\frac{R.b.c.}{10}\right]$$

Legend

W_R = weight of rotor or propeller-lb

R = rotor radius-ft

b = number of blades per rotor

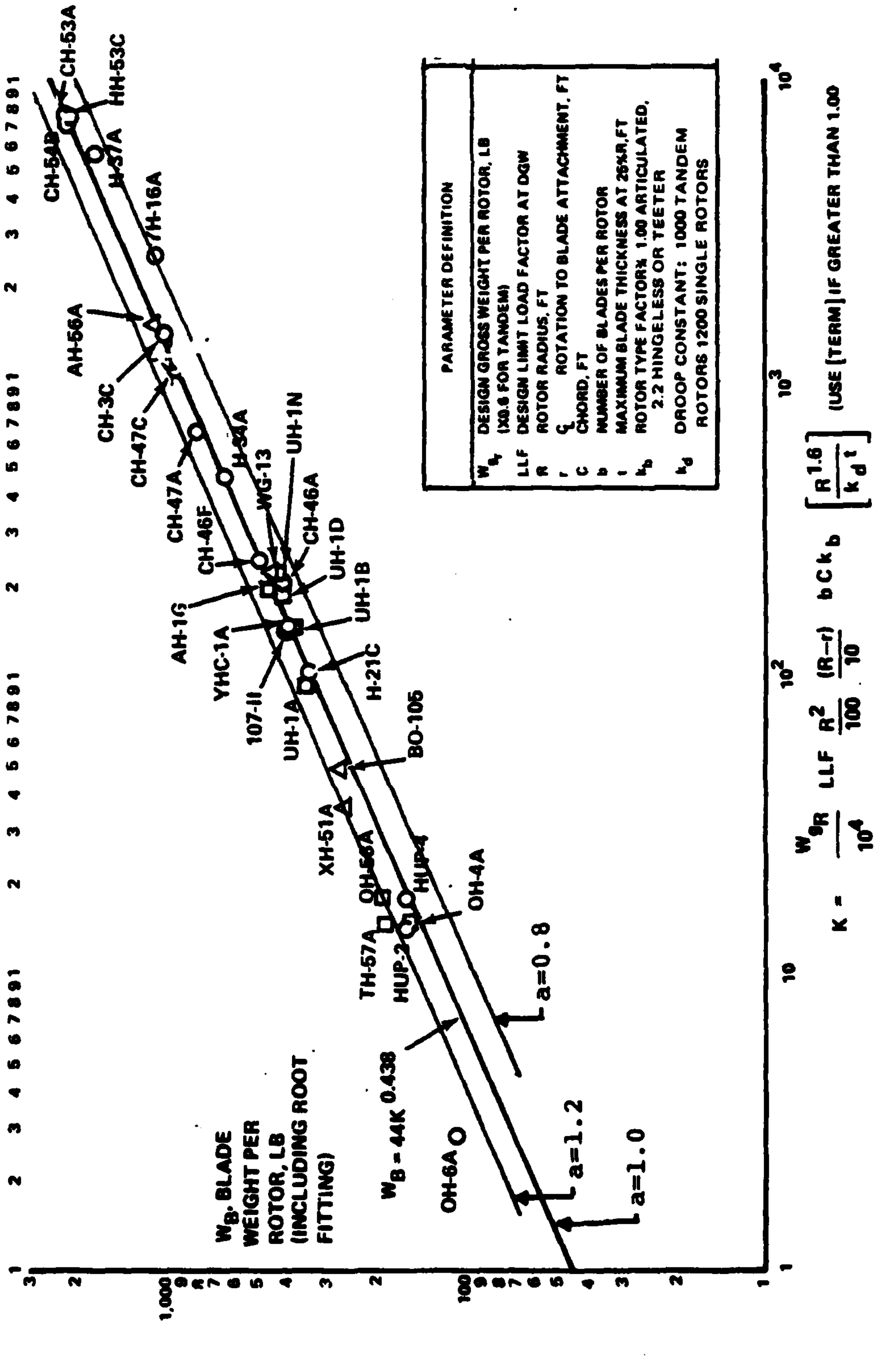


Figure 4-38. Rotor Blade Weight Trend.

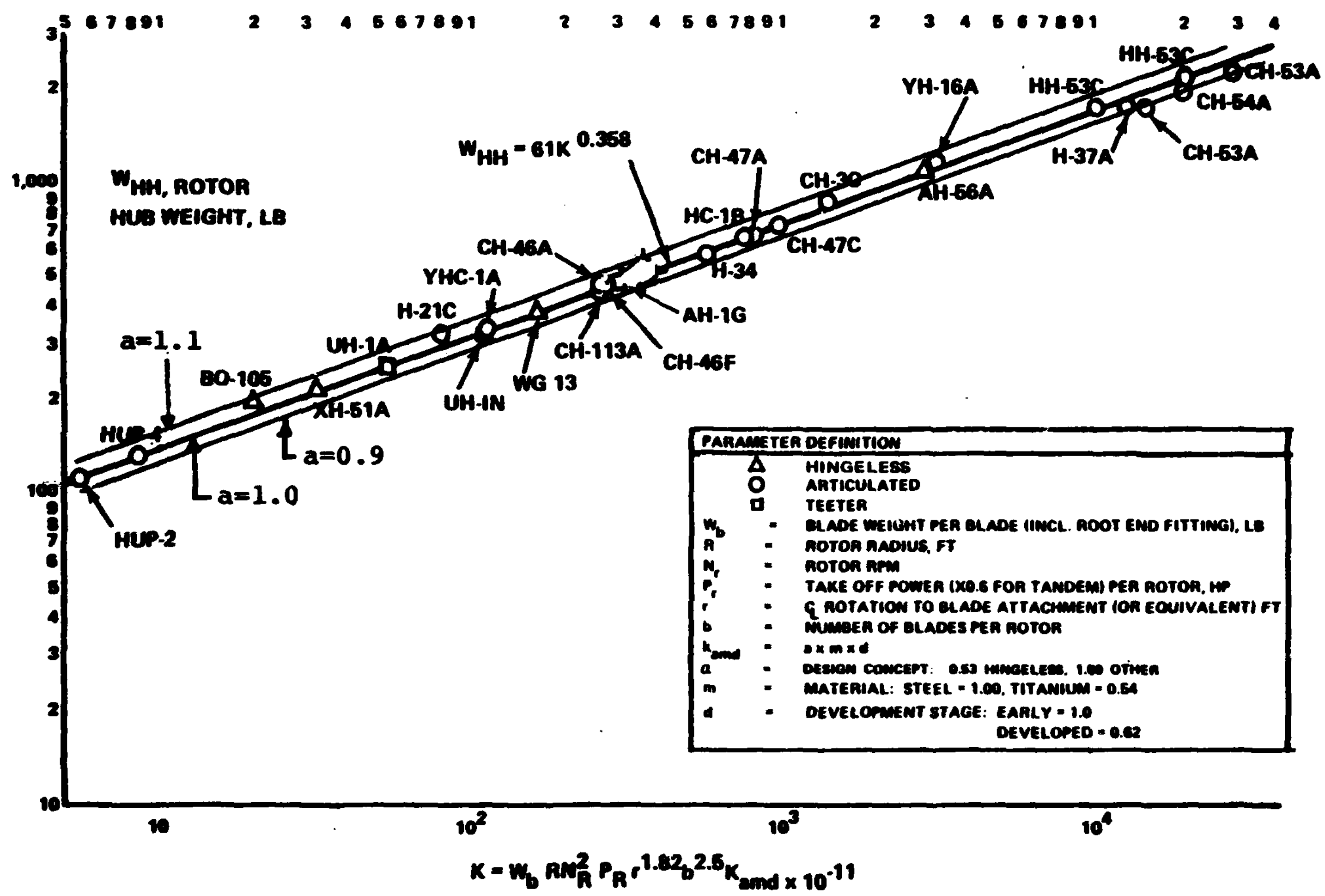


Figure 4-39. Rotor Hub and Hinge Weight Trend.

c = blade chord (average)-ft

HP_r = horsepower (xmsn limit per rotor)

V_{tl} = design limit tip speed-ft/sec

r = center line of rotation to average blade attachment point-ft

a = adjusting factor for type of system (see Figure 4-40)

In the trend equation the constant 14.2 is the average for the various rotor group weights presented in Figure 4-40. The expression a is the adjustment factor for the type of system; i.e., semirigid, pressure cycle, etc. To determine the value of k_{AR} in the propulsion block of the weight input sheet, multiply the type of system desired a by the constant 14.2. Blade folding, if required, is entered in k_{15} as a percentage factor of the total computed rotor weight. The input value would be between 1.15 to 1.25 depending on the folding requirements.

The k_{PA} block on the weight input sheet allows the auxiliary rotor input power to be increased or decreased as a fractional part of input power. (k_{PA} = 0.9 would decrease the power by 10 percent, 1.1 would increase the power by 10 percent.)

The k_{VTAR} block on the weight input sheet allows the auxiliary tail rotor tip speed to be increased or decreased as a fractional part of the input tip speed (k_{VTAR} = 0.9 would decrease the tip speed by 10 percent, 1.1 would increase it by 10 percent). The nominal input values for k_{PA} and k_{VTAR} is 1.0.

Tail Group

The tail group consists of the horizontal tail, vertical tail, ventral and tail rotor. Tail weights are determined as follows:

- Horizontal Tail - Its weight is based on a unit weight per square foot (PSF). The unit weight will normally vary between 1.0 and 2.0 PSF, depending on the type of tail being employed. The unit weights of the horizontal tails of some existing helicopters are presented as a guide for inputting the unit value in the k_{HT} block of the weight input sheet.

OH - 58A	1.1 lb/ft^2 - fixed
UH - 1H	1.3 lb/ft^2 - movable
UH - IN	1.6 lb/ft^2 - stabilizer

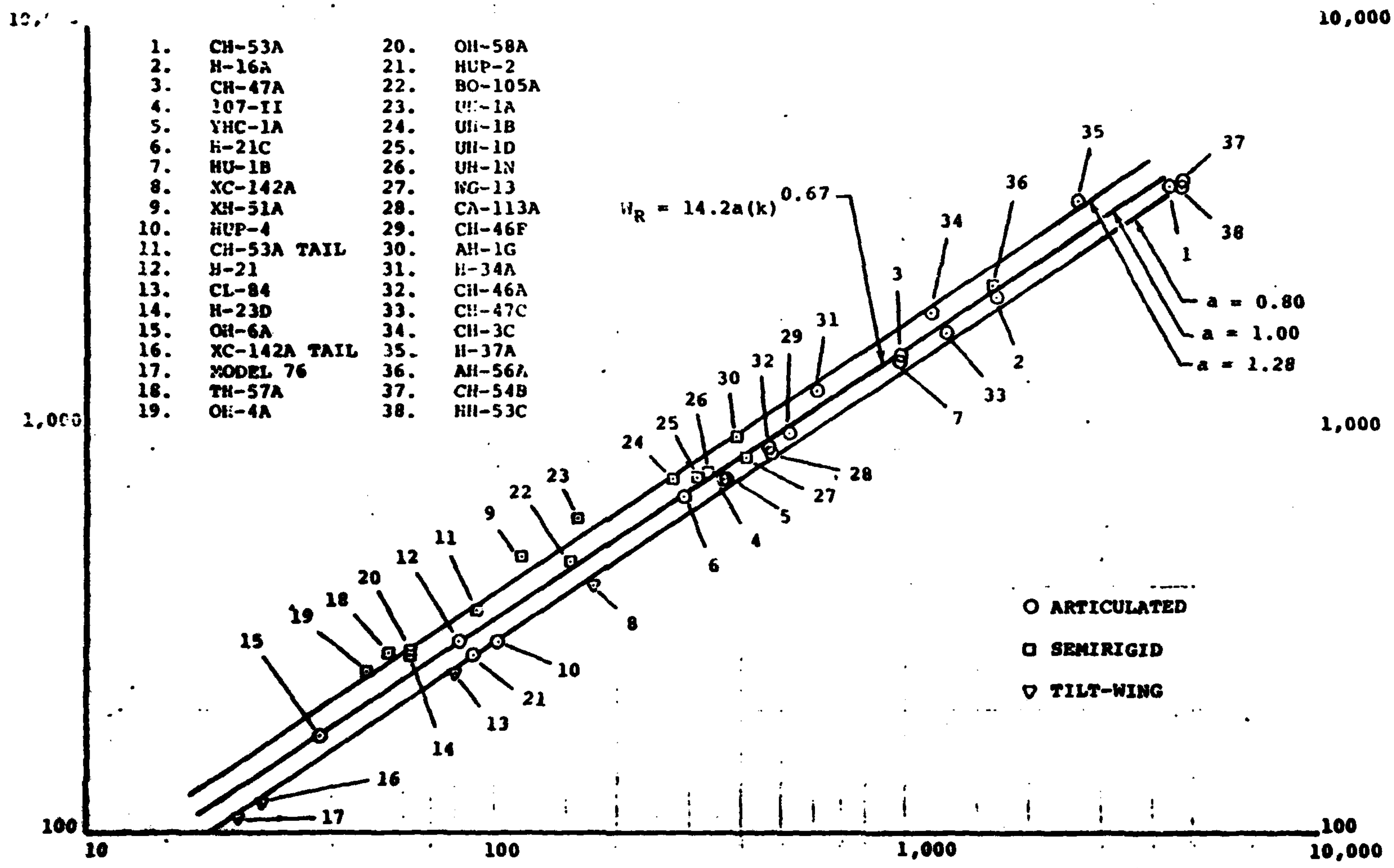


Figure 4-40. Rotor Group Weight Trend.

If horizontal tail fold is required, input this as a percentage of the total horizontal tail weight in the k_9 block of the input sheet (refer to Table 4-15).

- Vertical Tail and Ventral - The combined weights of vertical tail and ventral are included in the weight of the fuselage. The combined wetted area of both must be added to the fuselage wetted area.

- Tail Rotor - The weight of the tail rotor is derived from the following overall rotor trend equation:

$$W_R = 14.2\ a\ (k)^{0.67},$$

Where

$$k = \left[r\right]^{0.25} \left[\frac{HPr}{100}\right]^{0.5} \left[\frac{Vtl}{100}\right] \left[\frac{R.b.c.}{10}\right]$$

Legend

W_R = weight of rotor or propeller-lb

R = rotor radius-ft

b = number of blades per rotor

c = blade chord (average)-ft

HP_r = horsepower (xmsn limit per rotor)

V_{tl} = design limit tip speed-ft/sec

r = center line of rotation to average blade attachment point-ft

a = adjusting factor for type of system (see Figure 4-40)

This is the same equation used to determine the weight of the auxiliary rotors. The trend is explained above under Auxiliary Rotors or Propellers. If blade folding is required, a factor as a fraction of the computed tail rotor weight must be placed in k_{14} on the weight input sheet. Fold penalties normally vary between 0.15 and 0.25 of total rotor weight depending on the fold requirements. A value for k_{TR} must be inserted in its proper location on the weight input sheet.

Body Group

The weight of the body structure is determined from the following equation:

$$W_{BG} = 125 \ a \ (k)^{0.8},$$

Where

$$k = \left\{\left[\frac{W_g}{10^4}\right]\left[\eta\right]\left[\frac{S_f}{10^3}\right]\left[L_c + L_{rw} + \Delta CG\right]\right\}^{0.5}\left[\text{Log } V_{MAX}\right]$$

Legend

W_g = structural design gross weight - lb

η = ultimate load factor

S_f = wetted area of fuselage - ft^2 (includes fairings, pod, vertical tail and ventral)

L_c = length of cabin (measured from nose to end of cabin floor) - ft

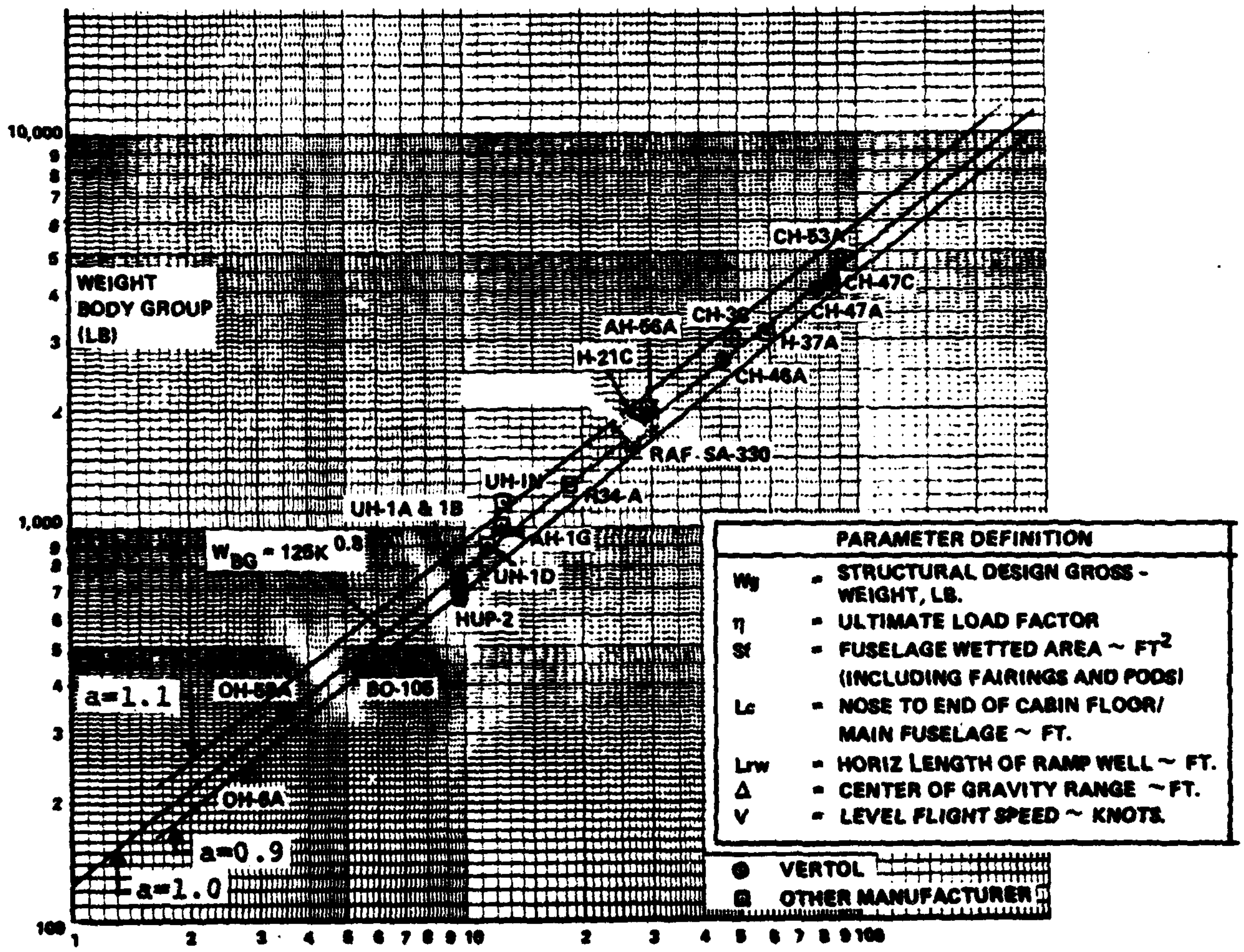
L_{rw} = length of rampwell - ft

ΔCG = center of gravity range at design gross weight - ft

V_{MAX} = maximum speed - kn

a = body correction factor

Figure 4-41 presents a group of commercial and military single and tandem rotor helicopters. A mean line of 125 has been selected as the average for all the aircraft shown. The body correction factor a permits the 125 constant to be corrected in accordance with the configuration being analyzed. When a large number of cutouts are required as in the case of large doors, many windows, large floor cutouts, etc., the a term would be greater than 1. Where the fuselage is relatively clean, the a could be less than 1. Refer to Figure 4-41 to select the a term which best describes the configuration. The revised constant 125a is the k_B term to be inserted in the appropriate box on the weight input sheet. The center of gravity range, in feet, must also be placed in the Δ_{CG} block on the input sheet.



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$$K = \left[\frac{W_g}{10^3}\,\eta\,\frac{S_f}{10^3}\,(L_c + L_{rw} + \Delta)\right]^{0.5} \mathrm{Log}\, V_{max}$$

Figure 4-41. Body Group Weight Trend.

Alighting Gear

For the normal tricyle gear geometry, the total landing gear weight including the running gear (wheels, tires, brakes, etc.), structure (shock struts, drag struts, support structure, etc.), and controls (retraction, steering, systems, etc.) is expressed as a percentage of the design gross weight where:

$$W_{LG} = (k_{LG})\, W_g$$

Where W_{LG} = total weight of the landing gear (including tail bumper)

$k_{LG} = \dfrac{\text{landing gear weight}}{\text{gross weight}}$

W_g = design gross weight

The percentage will normally vary between 0.015 to 0.050 depending on the design limit sink speed and the complexity of the system. Conventional landing gear without retraction, operating on improved runways normally run between 0.015 to 0.04. Adding retraction usually adds another 0.005 to 0.01. Skid type landing gear usually weigh about 0.015 times design gross weight.

The main gear usually weighs about 80 percent of the total gear weight. The k term in the weight expression above is the value that must be placed in the k_{LG} box of the weight input sheet. The weight of the main gear is included by placing 0.80, or your estimate of the main gear weight as a fraction of the total gear weight, in the k_{MG} location on the weight input sheet.

Table 4-12 is included as a guide in selecting k_{LG}. It includes the total gear weight as a percentage of the gross weight for a sampling of helicopters.

Engine Section (Primary and Auxiliary)

The engine section weight appears as item 10 in Table 4-10. It is basically the engine mounts, engine nacelle structure and firewalls, air induction and support structure.

- Engine mounts - The weight of the engine mounts is determined from the expression

$$W_{EM} = N_E \left(W_E \times N_{CLF}\right)^{0.41}$$

TABLE 4-12. LANDING GEAR WEIGHTS

AIRCRAFT	GROSS WEIGHT (LB)	TOTAL GEAR WEIGHT (LB)	PERCENT OF GROSS WEIGHT
OH-6A	2400	58	.024
XH-51A	3500	134	.038
BO-105	4410	96	.022
UH-1B	6600	112	.017
UH-1D	6600	118	.018
UH-1N	10000	121	.012
UH-34D	11291	413	.036
AH-56A	16995	605	.036
CH-46A	19000	589	.031
CH-3C	19500	690	.035
CH-46D	20800	587	.028
CH-46E	20800	655	.031
HH-3B	21187	700	.033
CH-47A	28550	1060	.037
CH-47B	33000	1086	.033
CH-47C	33000	1076	.033
CH-53A	35042	1014	.029
CH-54A	38000	1794	.047
CH-54B	64700	2277	.035

Enter the crash load factor N_{CLF} in the k_{CLF} block of the weight input block. (This considers both the primary and/or auxiliary engine sections.)

- Engine nacelle structure, supports and firewalls

These items are determined from the expression

$$W_{NAC} = N_E \, (S_{NAC}) \, (PSF)$$

Enter the estimated unit weight in pounds per square foot (PSF) in the k_{NAC} and/or the k_{NACA} blocks of the input sheet. This value normally varies between 0.75 and 1.25 PSF. It could go as high as 2.0 psf if the cowling is used as a walkway or work platform.

- Air induction - The weight of the air induction system is determined from the expression

$$W_{AIP} = N_E \left(\pi E_{DIA} \times L_{AIP} \right) \quad (PSF)$$

Enter the estimated unit weight in pounds per square foot (PSF) in the k_{AIP} and/or the k_{AIA} blocks of the input sheet. This value normally varies between 0.7 to 1.0 PSF. An option is provided for determining the weight of the air induction system. If k_{AIP} or k_{AIA} is greater than 5.0 the program automatically assumes the value is the weight of the air induction system in pounds.

The k_{NS} term on the input sheet is a nacelle strut factor used when an engine is suspended from an aircraft employing a wing. Enter a unit weight value in PSF in the k_{NS} box. The nominal value is 0.

Legend

W_{EM} = weight of engine mounts - lb

N_E = number of primary engines

W_E = weight of each primary engine - lb

N_{CLF} = aircraft crash load factor

W_{NAC} = weight of each primary engine nacelle - lb

S_{NAC} = wetted area of each nacelle - sq. ft.

PSF = pounds per square foot

W_{AIP} = weight of air induction system - feet

E_{DIA} = primary engine DIA - feet

L_{A1P} = length of air inlet duct

The weight of the primary and/or auxiliary engines is determined as part of the engine sizing routine considered elsewhere in the program. There is no provision for determining the engine weight(s) on the weight input sheet. The Δ_{WP} and K_{18} and K_{19} blocks of the input sheet provide a method for adding weight to the engine(s) if desired. (Refer to Table 4-13.

The engine installation weights represent the total weight of items 14, 15, 16, 17, and 19 shown on the weight summary form, Table 4-10. The weights of engine (primary and auxiliary) installation items will vary depending on the type and powerplant arrangement of the configuration being sized. No attempt is made here to describe all the various approaches that may be used to evaluate their weights, but instead a simple method of taking a percentage of the weight of the dry engines is used to define the weight of the engine installation. The percentages applied will depend on the judgment of the user. Table 4-13 presents the engine installation weights as a percentage of the engine weight for a group of existing helicopters. This may be used as a guide for selecting the weight fraction to be placed in k_{PEI} and/or k_{AEI} on the weight input sheet. An option is provided for determining the weight of the engine installation. If k_{PEI} or k_{AEI} is greater than 1.0, the program automatically assumes the value is the weight of the engine installation in pounds.

Fuel System

The weight of the fuel system, defined as k_{FS} in the propulsion block of the weight input sheet, will vary depending on the capacity, type, and complexity of the system required. For aircraft having simple fuel systems located in the fuselage, sponsons or wing, the value for k_{FS} would range between 0.02 and 0.07; for aircraft requiring self-sealing tanks with more complex systems, the value would range between 0.10 and 0.15. The fuel system factors represent fuel system weight per pound of mission fuel required.

Drive System (Primary and Auxiliary)

The weight of the drive system (primary and auxiliary) including gear boxes, accessory drives, shafting, oil, supports, etc., is derived from the following equation:

$$W_{DS} = 250\ a\ (k_D)^{0.67},$$

where

$$k_D = \left[\frac{P_x}{N_R}\right] \left[z\right]^{1/4} \left[K_t\right]$$

TABLE 4-13. ENGINE INSTALLATION WEIGHTS

AIRCRAFT	AIRCRAFT ENG. WEIGHT (LB)	ENG. INSTAL. WEIGHT (LB)	PERCENT OF ENGINE WEIGHT
OH-6A	142	36	.254
XH-51A	244	97	.398
BO-105	424	81	.191
UH-1B	474	148	.312
UH-1D	501	147	.293
UH-1N	727	164	.226
UH-34D	1387	260	.187
AH-56A	695	337	.485
CH-46A	600	161	.268
CH-3C	611	130	.213
CH-46D	678	187	.276
CH-46E	886	207	.234
HH-3B	649	136	.210
CH-47A	1160	173	.149
CH-47B	1188	175	.147
CH-47C	1350	244	.181
CH-53A	1432	283	.198
CH-54A	1804	193	.107
CH-54B	2094	394	.188

Note: Engine installation weights include the total weight of the following items:

- Engine Exhaust System
- Engine Cooling
- Engine Controls
- Engine Starting
- Engine Lubrication

Legend

W_{DS} = weight of the drive system - lb (excluding tail rotor boxes and shafting)

P_X = drive system horsepower rating (tandem rotor P_X = 1.2 X takeoff rating)

N_R = rotor rpm at takeoff

Z = number of stages in main rotor drive

K_t = configuration factor; 1.00 for single rotor, 1.30 for tandem

a = drive system correcting factor

The drive system adjusting factor a is used to account for type, number of boxes, special features, etc., included in the drive system. Figure 4-42 gives typical examples of the a factor. To determine the k_{PDS} and/or the k_{ADS} figure to place on the weight input sheet, multiply the 250 constant by your selection of a. The k_{PDSZ} and/or k_{ADSZ} (number of stages) must also be placed in their respective locations on the input sheet. As a guide for determining the number of stages to input the following is offered:

	Stages
● Lightweight helicopters (less than 10,000 pounds gross weight)	2
● Medium weight helicopters (10,000 pounds to 30,000 pounds gross weight)	3-4
● Heavy weight helicopters (more than 30,000 pounds gross weight)	4-5

An additional guide in determining the number of stages is to assume one stage for each gear reduction in the drive system. This would include angle boxes. (Assume ¼ of a stage for 1:1 angle boxes.) The total additive sum of the stages resulting from this approach would then be placed in their respective k locations on the input sheet.

Tail Rotor Drive System

The weight of the tail rotor drive system, including shafting, etc., is derived from the following equation:

$$W_{DS} = 300\ a\ (k)^{0.8},$$

Where

$$k = \frac{HP_{Total} \times 1.1}{RPM_{Rotor}}$$

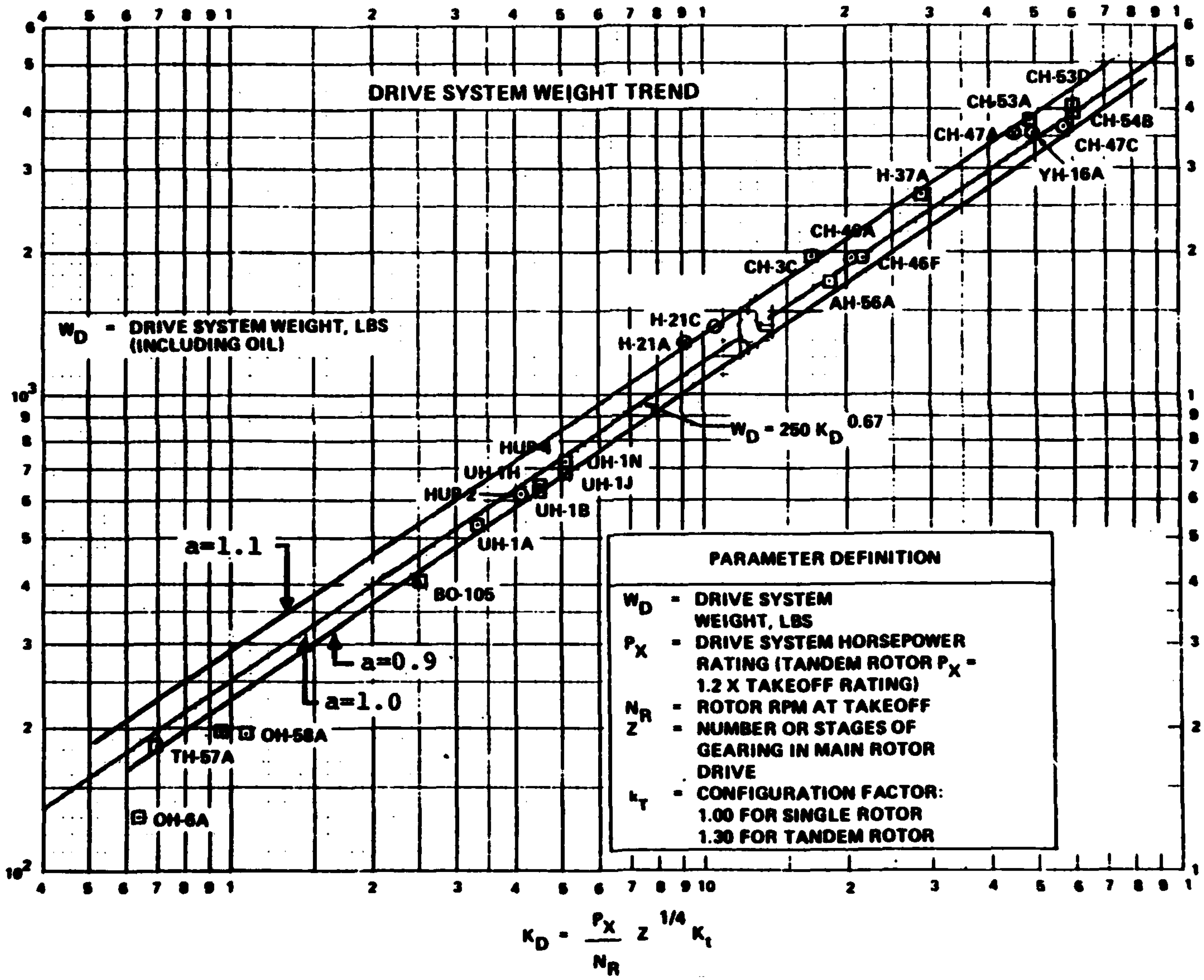


Figure 4-42. Drive System Weight Trend- Primary and Auxiliary.

Legend

W_{DS} = weight of drive system - lb

HP_{Total} = total tail rotor horsepower

RPM_{Rotor} = tail rotor design rpm

a = drive system adjustment factor

The factor a is an adjustment factor used to account for the type, number of boxes, and special features, etc. included in the drive system. Figure 4-43 gives typical examples of the a factor. To determine the k_{DS} value to place on the weight input sheet, multiply the 300 constant by your selection of a.

Flight Controls

The weight of the flight control system will vary depending on the type and system required (manual, power assisted, redundant, dual redundant, etc.) and the type of heicopter being configured (pure, winged, compound, propulsive tail, etc.). Aircraft control systems requiring power assistance and dual or triple redundant components will weigh more than configurations having simple, non-redundant systems. Considerations must be given to these factors when determining the flight control constants to insert on the weight input sheet.

An equation which includes a combined series of weight trend expressions applicable to most any type of helicopter configuration is presented below. It includes factors which can be isolated and applied to the particular vehicle being analyzed. Values for the various k factors described must be put in their proper locations on the weight input sheet. A description of the items comprising each of the control sub-groups is included along with a range of k input values. Refer to the referenced trend cur es included for each of the major control groups as an aid in selecting the respective k values.

$$W_{FC} = k_{cc}\left[\frac{W_g}{1000}\right]^{0.41} + k_{RC}\left[\frac{C\sqrt{R\,W_B}}{1000}\right]^{1.11} + k_{SC}\left[\frac{W_R}{100}\right]^{0.84}$$

$$+ k_{FW}\left[W_g\right] + k_{TM}\left[W_g\right] + k_{SAS} + K_{RCA}\left[W_R\right]$$

$$+ k_{SCA}\left[\frac{W_R}{100}\right]^{0.84} + k_{Misc.}$$

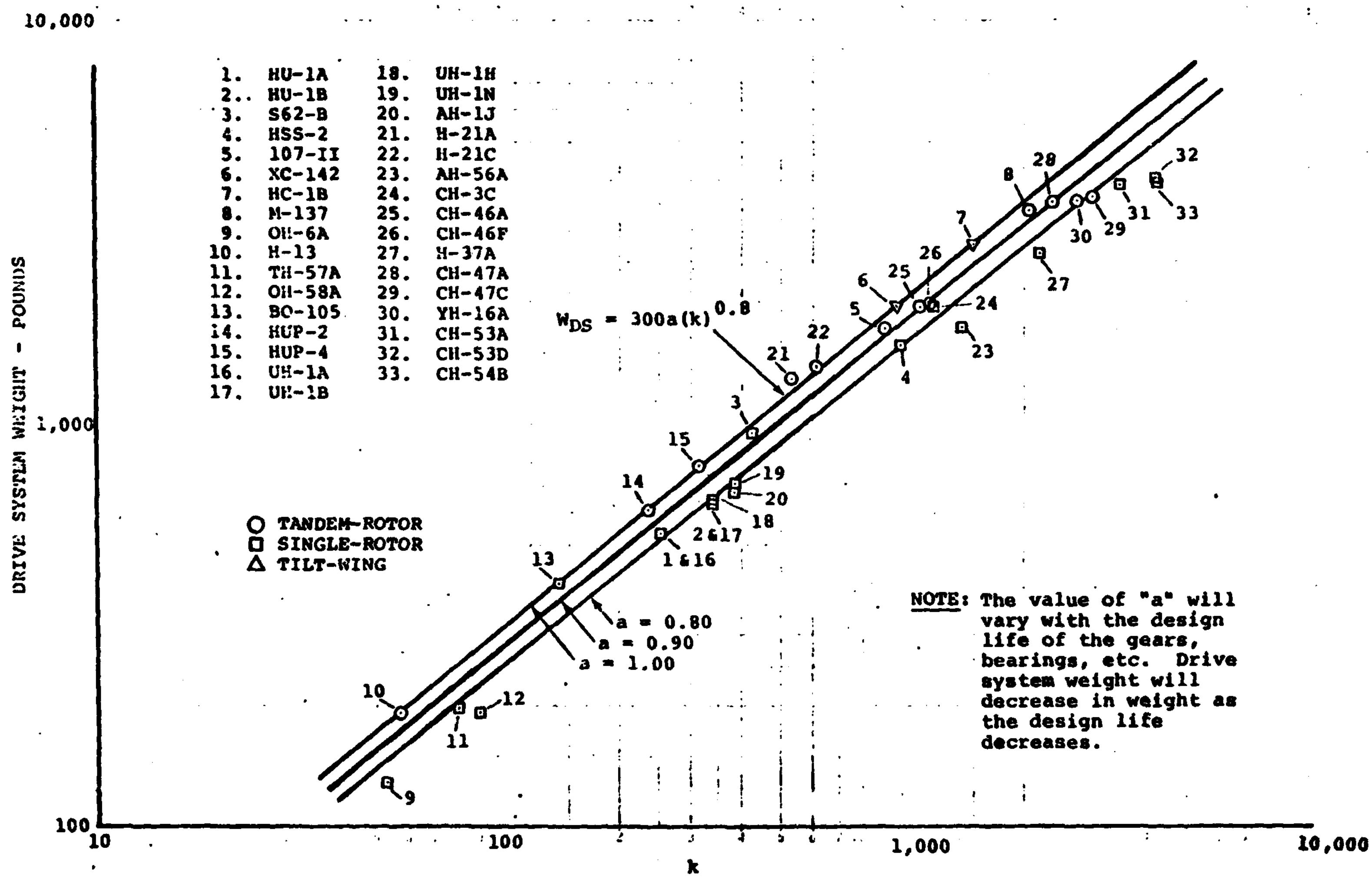


Figure 4-43. Drive System Weight Trend-Tail Rotor.

Legend

W_{FC} = weight of flight controls - lb

W_g = design gross weight - lb

C = rotor blade chord - ft

R = rotor radius - ft

W_b = rotor blade weight per rotor - lb

k_{CC} = constant for cockpit controls = 26

Cyclic and collective control sticks and linkages, pedals, cables and rods (Figure 4-44)

k_{RC} = constant for main rotor controls

All components from and including the power actuators up through the pitch links. Major items included are the actuators, swashplate, and pitch links (Figure 4-45).

If $k_{RC} \geq 1.0$, the following equation is used.

$W_{RC} = k_{RC}\ C\ \dfrac{RW_B}{10000}$ typical values are k_{RC} = 18 to 23.

If k_{RC} 1.0, the mom rotor controls are weighed using the following:

$W_{RC} = k_{RC}\ (W_R - N_R W_{BF})$ where W_R is total rotor weight and NRWBF is blade folding.

k_{SC} = constant for main rotor systems and hydraulics = 25 to 35

All components between the cockpit controls and the rotor controls including actuators, artificial feel system, mechanical programmer, bellcranks, rods, idlers, etc. (Figure 4-46)

Main hydraulic systems including pumps, reservoirs, accumulators, filters, valves, lines, fluid, and supports (Figure 4-46)

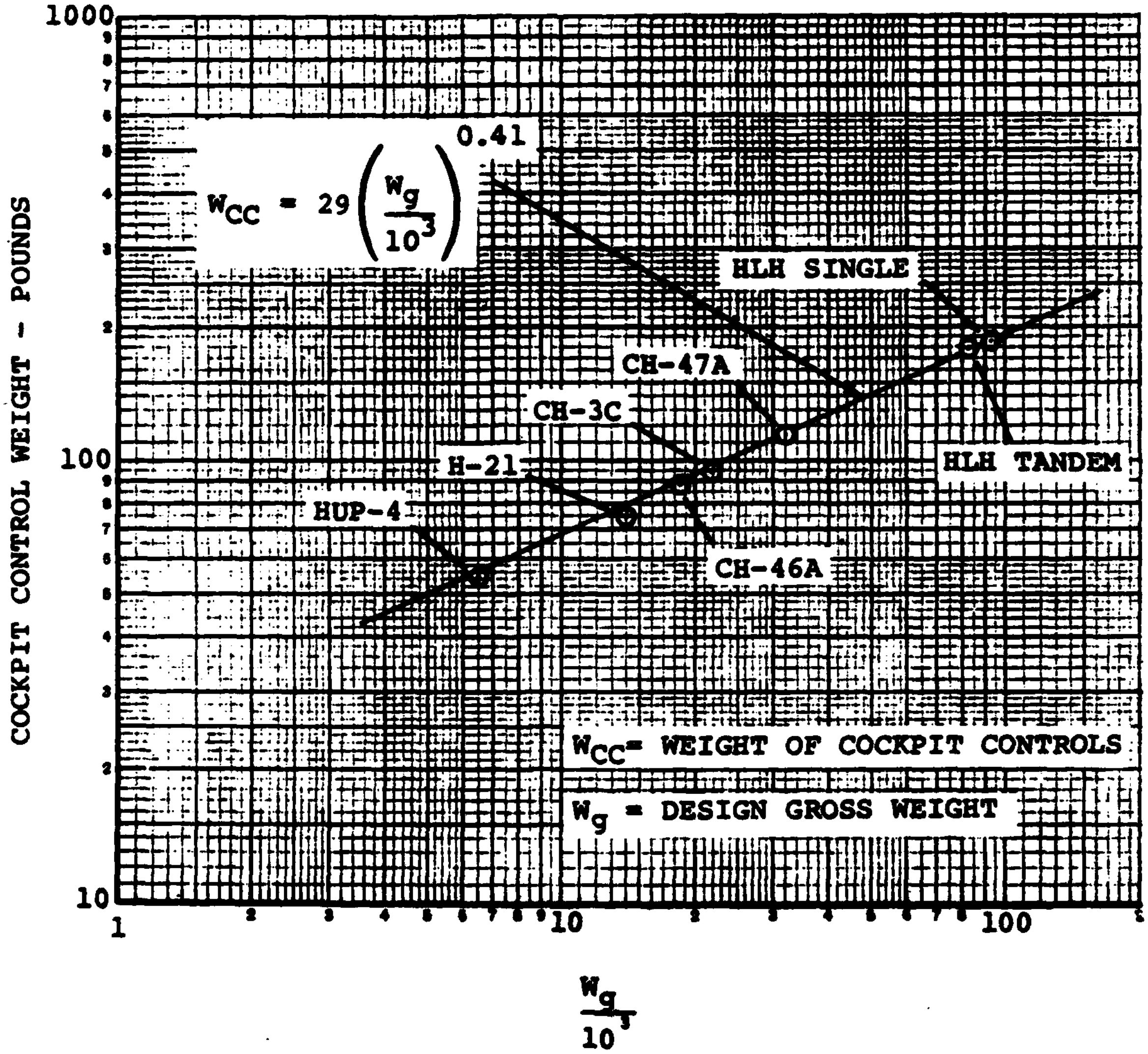


Figure 4-44. Cockpit Controls Weight Trend.

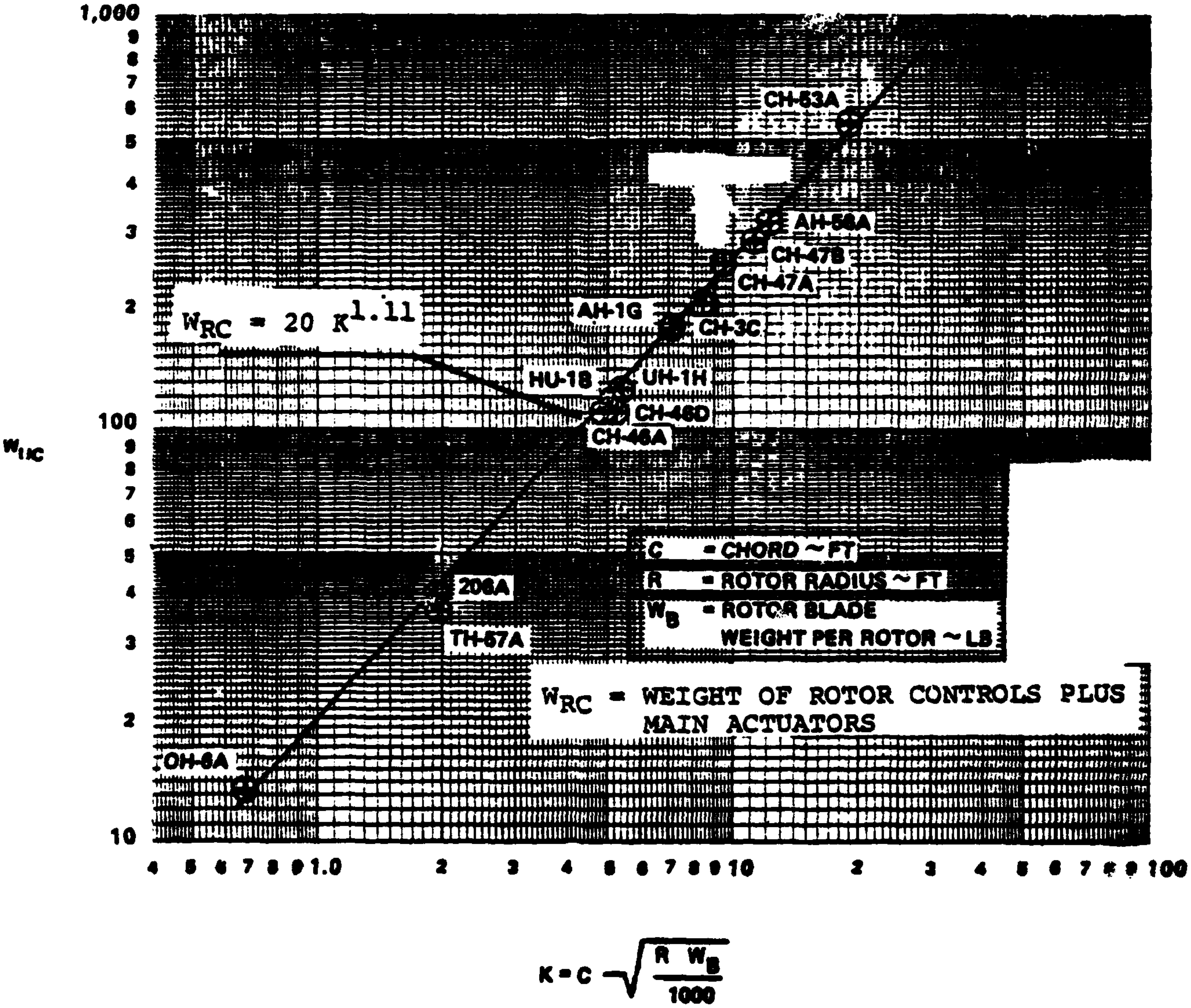


Figure 4-45. Rotor Controls Weight Trend.

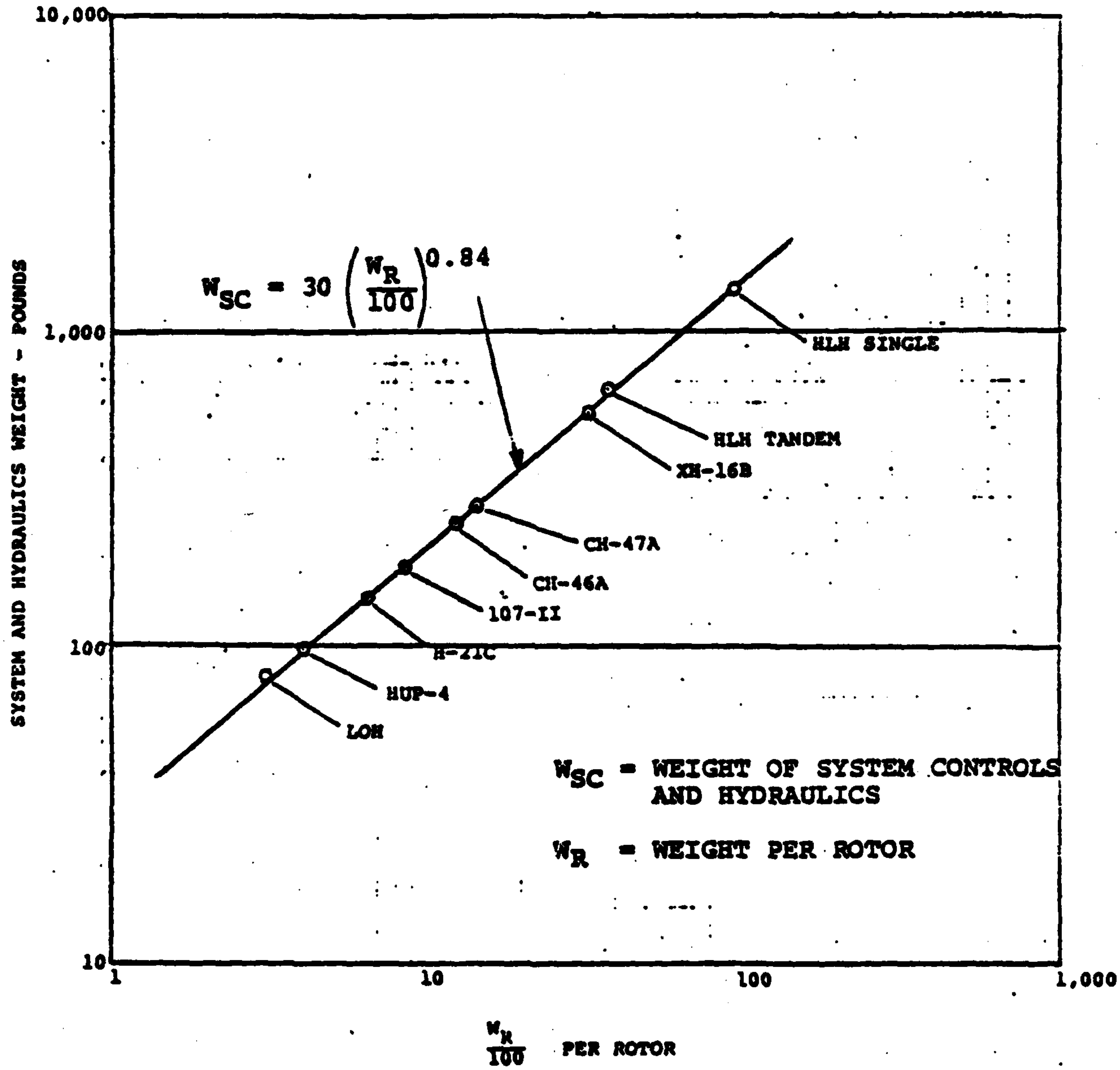


Figure 4-46. Rotor System and Hydraulics Weight Trend.

k_{FW} = constant for conventional fixed-wing controls = 0.005 to 0.020, depending on complexity and number of functions required

All components, actuators, and supports associated with moving the control surfaces - LE umbrellas, flaperons, spoilers, and tail surfaces

k_{TM} = constant for tilting mechanism - 0.005 to 0.015

All components and supports required to tilt the wing including actuators, power control units, mechanical system, fittings, and hardware. The k_{TM} value will vary proportionately with the hinge moment and/or wing transition rate required.

k_{SAS} = constant for stability-augmented system = 20 pounds to 100 pounds, depending on system required

k_{RCA} = constant for auxiliary rotor controls

Similar to k_{RC} - provides rotor control weights for auxiliary propulsive systems (pusher props, ducted fan, etc., Figure 4-47)

k_{SCA} = constant for auxiliary rotor system controls

Similar to k_{SC}- provides rotor system control weights for auxiliary propulsive systems (pusher props, ducted fans, etc., Figure 4-46)

$k_{Misc.}$ = estimated weight input in pounds for any items not covered above

Fixed Equipment

The weight of the fixed equipment is included in the weight empty and consists of the following groups: auxiliary powerplant, instruments, hydraulics and pneumatics, electrical, avionics, armament, furnishings and equipment, air-conditioning, anti-icing and load and handling (Table 4-10).

The weight of the fixed equipment will vary with the type and requirements of the aircraft under studv. The largest variation in fixed equipment weights usually appears in the avionics and the furnishings and equipment groups. The avionics group reflects communication and navigational requirements; the furnishings and equipment group normally reflects cabin size and personnel accommodations (pilots seats, troop seats, etc.). Table 4-14 presents some typical examples of the fixed equipment weights for some existing military helicopters.

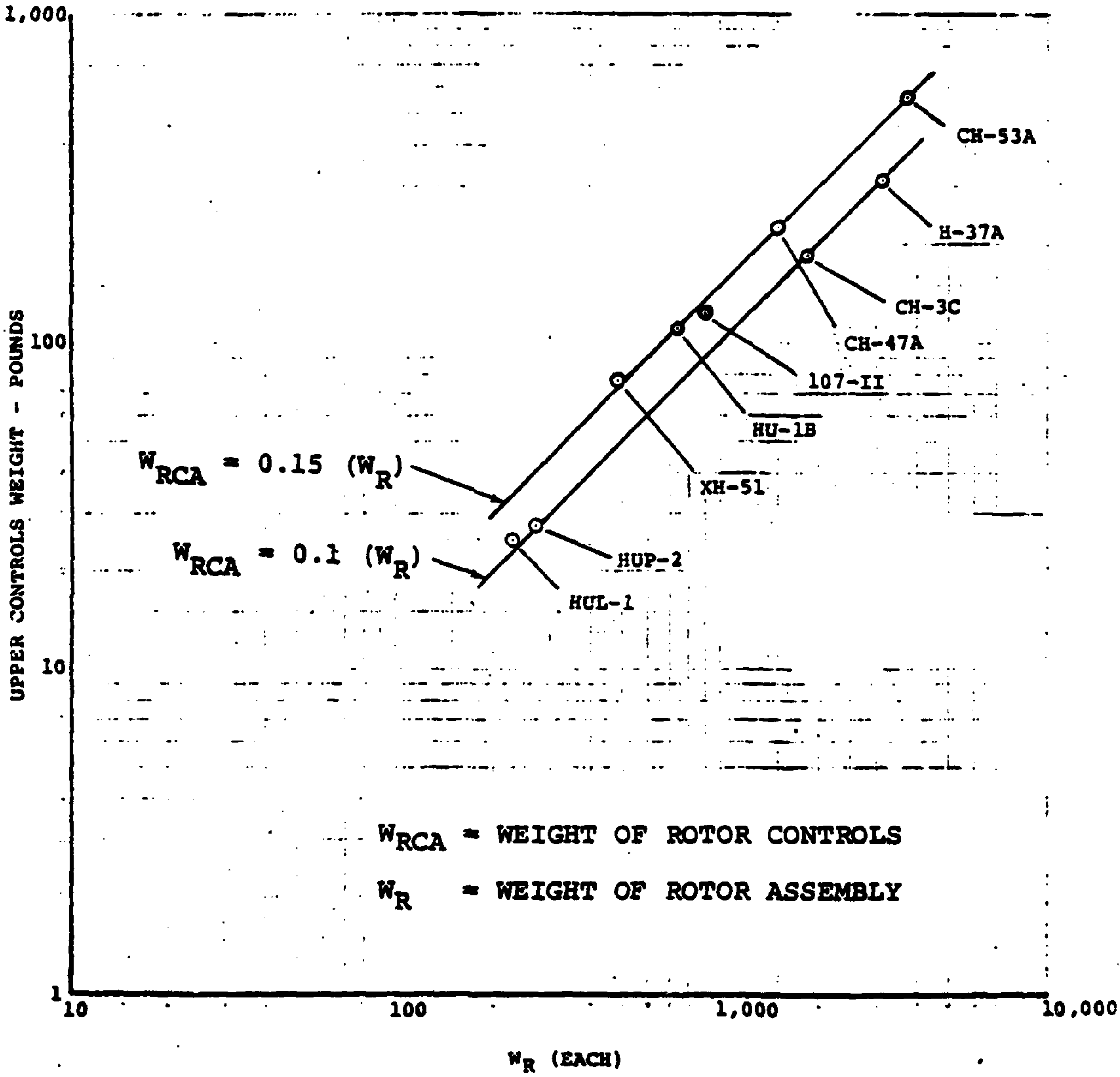


Figure 4-47. Auxiliary Rotor Controls Weight Trend.

BOEING VERTOL COMPANY

WEIGHT SUMMARY - PRELIMINARY DESIGN
MIL-STD-1374

TABLE 4-14.
FIXED EQUIPMENT AND FIXED USEFUL LOAD WEIGHTS

	CH-46A	CH-47A	CH-53A	CH-3C	AH-56A	107-II-10
WING						
ROTOR						
TAIL						
SURFACES						
ROTOR						
BODY						
BASIC						
SECONDARY						
ALIGHTING GEAR GROUP						
ENGINE SECTION						
PROPULSION GROUP						
ENGINE INST'L						
EXHAUST SYSTEM						
COOLING						
CONTROLS						
STARTING						
PROPELLER INST'L						
LUBRICATING						
FUEL						
DRIVE						
FLIGHT CONTROLS						
AUX. POWER PLANT	100	103	204	224	136	-
INSTRUMENTS	169	161	393	232	126	98
HYDR. & PNEUMATIC	163	227	112	66	86	-
ELECTRICAL GROUP	620	560	594	450	377	583
AVIONICS GROUP	386	274	612	437	609	602
ARMAMENT GROUP	-	-	18	-	548	-
FURN. & EQUIP. GROUP	788	896	971	569	273	1300
ACCOM. FOR PERSON.	182	391	298	208	165	555
MISC. EQUIPMENT	77	107	384	87	73	601
FURNISHINGS	481	329	214	175	-	-
EMERG. EQUIPMENT	48	69	75	99	35	144
AIR CONDITIONING	128	145	237	123	75	128
ANTI-ICING GROUP	186	34	77	37	42	13
LOAD AND HANDLING GP.	305	260	358	189	-	14
FIXED EQUIP, WEIGHT	2845	2660	3576	2327	2272	2738
CREW	540	600	660	645	400	400
TRAPPED LIQUIDS	20	41	18	20	31	28
ENGINE OIL	30	28	48	33	32	31
SURVIVAL KIT				63	-	
ARMOR					399	
GUNS					1235	
ATTENDANT						150
BAGGAGE						370
FUEL						
FIXED USEFUL LOAD	590	669	726	761	2097	979

REV.

FORM 20391 (2/73)

The total weight of the fixed equipment, W_{FE}, must be placed in the W_{FE} block of the weight input sheet.

Fixed Useful Load

The weight of the fixed useful load represents a portion of the useful load. It includes the crew, trapped and unusable fuel and oil, guns, weapons, racks or pylons and any other fixed items of useful load which makes the aircraft operational. Typical weights for fixed useful load items are included in Table 4-14 as a guide for inputting a number in the W_{FUL} block of the weight input sheet.

Payload

The weight of the payload is determined by the mission requirements. The total weight of the payload must be put in the W_{PL} block of the weight input sheet.

Incremental Group Weights

The incremental group weights section of the weight input sheet is provided to enable the user to add fixed increments of weight where desired. Definitions and values for some of the items in this group have already been discussed. ΔW_{FC}, ΔW_P, and ΔW_{ST} represent incremental weights of the flight controls group, propulsion group, and structural group, respectively. Any value inserted in the incremental group weight section remains constant regardless of gross weight. The nominal value for any block in this section is 0, except for R_M which is nominally 1.0.

Group Weight Information

The nominal value for items in this section of the weight input sheet is 0, except as noted in the text. All blocks must be filled in. Definitions and constants for the various k factors have been previously discussed in the respective subgroup definitions.

Multiplicative Factors

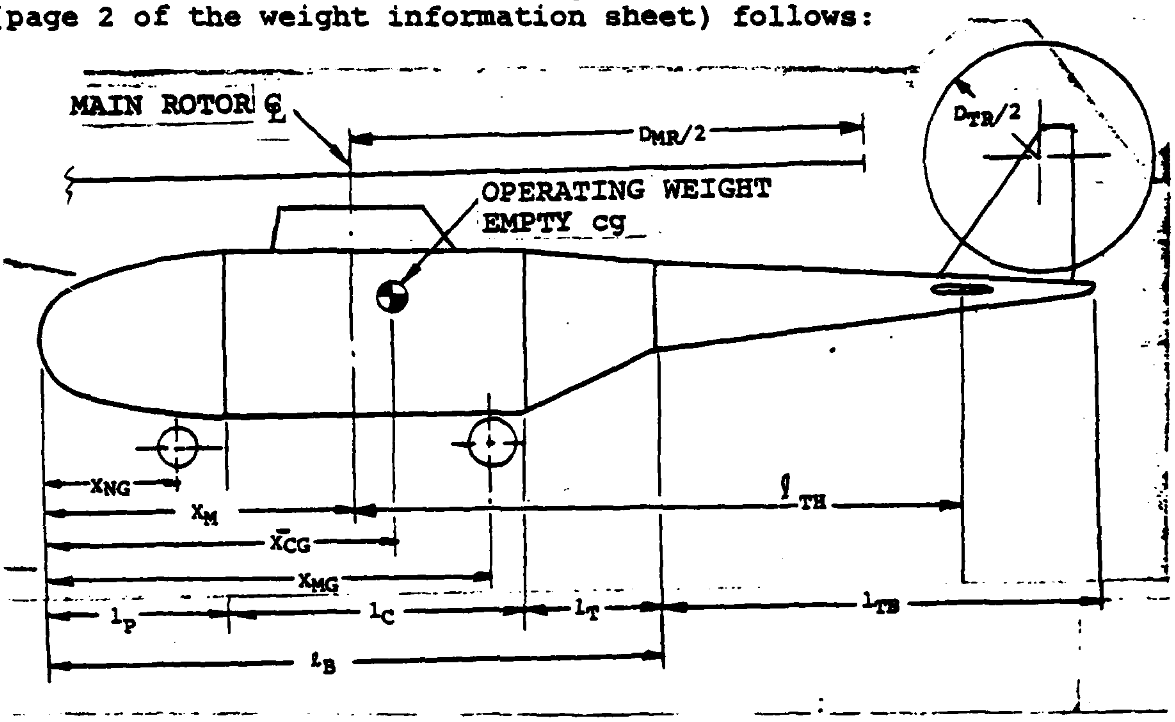
The multiplicative factors described as K_1 through K_{20} on the weight input sheet provide the capability of performing weight sensitivity studies. The factors are nominally 1. All blocks must be filled in. To vary the weight of any subgroup (k_{CC}, k_B, k_{DS}, etc.), insert the desired value in the appropriate multiplicative box. Refer to Table 4-15 to relate the various k factors with their respective groups. Inserting a value of 1.1 would increase the weight of the respective group by 10 percent; a value of 0.9 would decrease it by 10 percent, etc. The values in this group will vary with gross weight.

TABLE 4-15.
MULTIPLICATIVE FACTORS

K	LOCATION	LETTER CODE	DESCRIPTION
K1	2654	W_{RC}	WEIGHT OF MAIN ROTOR CONTROLS
K2	2655	W_{SC}	WEIGHT OF MAIN ROTOR SYSTEM CONTROLS
K3	2656	W_{FW}	WEIGHT OF FIXED WING CONTROLS
K4	2657	W_{RCA}	WEIGHT OF AUXILIARY ROTOR CONTROLS
K5	2658	W_{SCA}	WEIGHT OF AUXILIARY ROTOR SYSTEM CONTROLS
K6	2659	W_B	WEIGHT OF BODY
K7	2660	W_{LG}	WEIGHT OF LANDING GEAR
K8	2661	W_W	WEIGHT OF WING
K9	2662	W_{HT}	WEIGHT OF HORIZONTAL TAIL
K10	2663	W_{NAC}	WEIGHT OF PRIMARY NACELLE
K11	2664	W_{NACA}	WEIGHT OF AUXILIARY NACELLE
K12	2665	W_{PRB}	WEIGHT OF PRIMARY ROTOR BLADES
K13	2666	W_{PH}	WEIGHT OF PRIMARY ROTOR HUB
K14	2667	W_{TR}	WEIGHT OF TAIL ROTOR
K15	2668	W_{AR}	WEIGHT OF AUXILIARY ROTOR
K16	2669	W_{PDS}	WEIGHT OF PRIMARY DRIVE SYSTEM
K17	2670	W_{ADS}	WEIGHT OF AUXILIARY DRIVE SYSTEM
K18	2671	W_{PE}	WEIGHT OF PRIMARY ENGINE
K19	2672	W_{AE}	WEIGHT OF AUXILIARY ENGINE
K20	2673	W_{TRDS}	WEIGHT OF TAIL ROTOR DRIVE SYSTEM

4.11.2 Aircraft Balance

A preliminary aircraft balance for single rotor helicopters is included in the program which locates the main rotor system ℄ relative to the required center of gravity of the operating weight empty of the aircraft. A description of the input values to be included on the weight-balance information sheet (page 2 of the weight information sheet) follows:



LOC (2678) X_{CGF}/ℓ_B	Center of gravity of the fuselage, measured from the nose of the aircraft, as a fractional part of l_B.
LOC (2679) ΔCG_R	Distance in feet between the OWE center of gravity and the main rotor center line (negative value (-) is forward of OWE cg, plus value (+) is aft of OWE cg).
LOC (2680) X_{NG}/ℓ_B	Center of gravity of the nose gear measured from the nose of the aircraft, as a fractional part of l_B.
LOC (2681) X_{MG}/ℓ_B	Center of gravity of the main gear, measured from the nose of the aircraft, as a fractional part of l_B.

LOC (2682) X_{PE}/ℓ_B — Center of gravity of the primary engine package, measured from the nose of the aircraft as a fractional part of l_B. The engine package consists of the engine section, engine, engine installation and fuel system.

LOC (2683) $X_{PDS}/\Delta X_{PDS}$ — Center of gravity of the primary drive system measured as a fractional part of the distance between the main rotor and tail rotor. The tail rotor drive system weight and balance are computed and located automatically.

LOC (2684) X_{AV}/ℓ_B — Center of gravity of the avionics system, measured from the nose of the aircraft, as a fractional part of l_B.

LOC (2685) X_{FURN}/ℓ_B — Center of gravity of the furnishings and equipment, cockpit controls and a portion of the useful load (pilot and copilot), measured from the nose of the aircraft as a fractional part of l_B.

LOC (2686) X_{APU}/ℓ_B — Center of gravity of the APU, measured from the nose of the aircraft, as a fractional part of l_B.

LOC (2687) X_{AE}/ℓ_B — Center of gravity of the auxiliary engine package, measured from the nose of the aircraft, as a fractional part of l_B. The auxiliary engine package consists of the auxiliary engine section, auxiliary engine and auxiliary engine installation.

LOC (2688) $X_{ADS}/\Delta X_{ADS}$ — Center of gravity of the auxiliary drive system as a fractional part of the distance between the auxiliary engine and auxiliary rotor system.

LOC (2689) X_{AR}/ℓ_{TB} — Center of gravity of the auxiliary rotor and auxiliary rotor controls, measured from the nose of the aircraft, as a fractional part of $_{TB}$.

LOC (2690) X_{SC}/ℓ_B — Center of gravity of the system controls, measured from the nose of the aircraft, as a fractional part of l_B.

LOC (2691) X_{ASC}/ℓ_B — Center of gravity of the auxiliary system controls, measured from the nose of the aircraft, as a fractional part of l_B.

LOC (2692) W_{AV} — Total weight of the avionics group weight plus SAS input from flight controls column of weight input sheet.

LOC (2693) W_{FURN} — Total weight of furnishings and equipment group located in the pilot's compartment and the weight of the cockpit controls (CC) as determined from the input constant in flight controls column of weight input sheet.

LOC (2694) W_{APU} — Total weight of auxiliary power unit (APU) installation.

LOC (2695) K_{FVLS} — Fractional part of fixed useful load (pilot, co-pilot, etc.) located in the pilot's compartment.

LOC (2696) K_{TBBS} — Tail boom weight expressed as a fractional part of the computed body weight. The center of gravity of the tail boom is automatically computed in the program.

Items of the operating weight empty not included in the location descriptions presented above are located at the aircraft center of gravity as computed by the balance subroutine. An example of a completed weight-balance information sheet for a typical single rotor helicopter is shown below.

WEIGHT-BALANCE INFORMATION
(Required Only When MRPIND > 0)

Variable	Loc.	Value	Variable	Loc.	Value	Variable	Loc.	Value
(X_{CGF}/l_B)	2678	0.425	(X_{FURN}/l_B)	2685	0.334	W_{AV}	2692	469
ΔCG_R	2679	0.10	(X_{APU}/l_B)	2686	0.424	W_{FURN}	2693	416
(X_{NG}/l_B)	2680	0.216	(X_{AE}/l_B)	2687	0	W_{APU}	2694	172
(X_{MG}/l_B)	2681	0.754	$(X_{ADS}/\Delta X_{ADS})$	2688	0	K_{FULS}	2695	0.731
(X_{PE}/l_B)	2682	0.727	$(X_{AR}/l_{TB,s})$	2689	0	K_{TBBS}	2696	0.130
$(X_{PDS}/\Delta X_{PDS})$	2683	0.593	(X_{SC}/l_B)	2690	0.581			
(X_{AV}/l_B)	2684	0.485	(X_{ASC}/l_B)	2691	0			

Name ____________

Date ____________

Page ____________

Model ____________

Report ____________

GROUP WEIGHT STATEMENT

AIRCRAFT

(INCLUDING ROTORCRAFT)

ESTIMATED - CALCULATED - ACTUAL

(Cross Out Those Not Applicable)

CONTRACT NO. ____________

AIRCRAFT, GOVERNMENT NO. ____________

AIRCRAFT, CONTRACTOR NO. ____________

MANUFACTURED BY ____________

		MAIN	AUX
ENGINE	MANUFACTURED BY		
	MODEL		
	NO.		
	TYPE		

PAGES REMOVED	PAGE NO.

MIL-STD-1374 PART I

GROUP WEIGHT STATEMENT
WEIGHT EMPTY

Name____________ Page____________

Date____________ Model____________

Report____________

1	WING GROUP						
2	BASIC STRUCTURE - CENTER SECTION						
3	- INTERMEDIATE PANEL						
4	- OUTER PANEL						
5	- GLOVE						
6	SECONDARY STRUCTURE (Incl. Wing Fold Weight. Lbs.)						
7	AILERONS (Incl. Balance Weight Lbs.)						
8	FLAPS - TRAILING EDGE						
9	- LEADING EDGE						
10	SLATS						
11	SPOILERS						
12							
13							
14	ROTOR GROUP						
15	BLADE ASSEMBLY						
16	HUB & HINGE (Incl. Blade Fold Weight Lbs.)						
17							
18							
19	TAIL GROUP						
20	BASIC & SECONDARY STRUCT. - STABILIZER						
21	- FIN (Incl. Dorsal)						
22	VENTRAL						
23	ELEVATOR (Incl. Balance Weight Lbs.)						
24	RUDDERS (Incl. Balance Weight Lbs.)						
25	TAIL ROTOR - BLADES						
26	- HUB & HINGE						
27							
28	BODY GROUP						
29	BASIC STRUCTURE - FUSELAGE or HULL						
30	- BOOMS						
31	SECONDARY STRUCTURE - FUSELAGE or HULL						
32	- BOOMS						
33	- SPEEDBRAKES						
34	- DOORS, RAMPS, PANELS, & MISC.						
35							
36							
37	ALIGHTING GEAR GROUP (Type:)						
38	LOCATION	Running Gear*	Arrest Gear*	Structure	Controls		
39							
40							
41							
42							
43							
44							
45	ENGINE SECTION or NACELLE GROUP						
46	BODY - INTERNAL						
47	- EXTERNAL						
48	WING - INBOARD						
49	- OUTBOARD						
50							
51							
52	AIR INDUCTION SYSTEM						
53	DOORS, PANELS, & MISC.						
54							
55							
56							
57	TOTAL STRUCTURE (To Be Brought Forward)						

*Change to Floats & Struts for Water Type Gear.

MIL-STD-1374 PART I

GROUP WEIGHT STATEMENT
WEIGHT EMPTY

Name ____________ Page ____________
Date ____________ Model ____________
Report ____________

		Auxiliary		Main		
1	PROPULSION GROUP					
2	ENGINE INSTALLATION					
3						
4	ACCESSORY GEAR BOXES & DRIVE					
5						
6	EXHAUST SYSTEM					
7	ENGINE COOLING					
8	WATER INJECTION					
9	ENGINE CONTROL					
10	STARTING SYSTEM					
11	PROPELLER INSTALLATION					
12	SMOKE ABATEMENT					
13	LUBRICATING SYSTEM					
14	FUEL SYSTEM					
15	TANKS - PROTECTED					
16	- UNPROTECTED					
17	PLUMBING, etc.					
18	DRIVE SYSTEM					
19	GEAR BOXES, LUB SY & ROTOR BRK					
20	TRANSMISSION DRIVE					
21	ROTOR SHAFTS					
22	JET DRIVE					
23						
24	FLIGHT CONTROLS GROUP					
25	COCKPIT CONTROLS (Autopilot Lbs.)					
26	SYSTEMS CONTROLS					
27						
28						
29	AUXILIARY POWER PLANT GROUP					
30	INSTRUMENTS GROUP					
31	HYDRAULIC & PNEUMATIC GROUP					
32						
33	ELECTRICAL GROUP					
34						
35	AVIONICS GROUP					
36	EQUIPMENT					
37	INSTALLATION					
38						
39	ARMAMENT GROUP (Incl. Passive Prot. Lbs.)					
40	FURNISHINGS & EQUIPMENT GROUP					
41	ACCOMMODATION FOR PERSONNEL					
42	MISCELLANEOUS EQUIPMENT					
43	FURNISHINGS					
44	EMERGENCY EQUIPMENT					
45						
46	AIR CONDITIONING GROUP					
47	ANTI - ICING GROUP					
48						
49	PHOTOGRAPHIC GROUP					
50						
51	LOAD & HANDLING GROUP					
52	AIRCRAFT HANDLING					
53	LOAD HANDLING					
54						
55	MANUFACTURING VARIATION					
56	TOTAL FROM PAGE 2					
57	WEIGHT EMPTY					

GROUP WEIGHT STATEMENT
USEFUL LOAD AND GROSS WEIGHT

Name ____________________ Page ____________________

Date ____________________ Model ____________________

Report ____________________

1	LOAD CONDITION								
2									
3	CREW (No.)								
4	PASSENGERS (No.)								
5	FUEL	Location	Type	Gals.					
6	UNUSABLE								
7	INTERNAL								
8									
9									
10									
11	EXTERNAL								
12									
13									
14	OIL								
15	TRAPPED								
16	ENGINE								
17									
18	FUEL TANKS (Location)								
19	WATER INJECTION FLUID (Gals.)								
20									
21	BAGGAGE								
22	CARGO								
23									
24	GUN INSTALLATIONS								
25	GUNS	Location	Fix. or Flex	Quantity	Caliber				
26									
27									
28	AMMO.								
29									
30									
* 31	SUPP'TS								
** 32	WEAPONS INSTALL. (Incl. Submarine Detection Expendables)								
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46	EQUIPMENT								
47									
48	SURVIVAL KITS & LIFE RAFTS								
49									
50	OXYGEN								
51									
52									
53									
54									
55	TOTAL USEFUL LOAD								
56	WEIGHT EMPTY								
57	GROSS WEIGHT								

*If Removable and Specified as Useful Load.

**List Stores, Missiles, Sonobuoys, etc. Followed by Racks, Launchers, Chutes, etc. Not Part of Weight Empty. List Identification, Location, and Quantity for All Items Shown Including Installation.

GROUP WEIGHT STATEMENT
DIMENSIONAL AND STRUCTURAL DATA

MIL-STD-1374 PART I

Page ______________
Model ______________
Report ______________

Name ______________
Date ______________

1	WING, ROTOR & TAIL GROUPS	Span or Radius (Ft.)	Span at **** 25% Chord	Theo. Root ** Chord (In.)	Max. Thick. ** Root Chord (In.)	Theo. Tip Chord (In.) **	Max. Thick. ** Tip Chord (In.)
2	WING						
3							
4	MAIN ROTOR (Blades/Rotor)						
5	TAIL ROTOR (Blades/Rotor)						
6	HORIZ. TAIL						
7	VERT. TAIL						
8							
9	AREAS - (Sq. Ft.)	Wing	Main Rotor Blade Area	Tail Rotor Blade Area	Horiz. Tail	Vert. Tail	Dorsal
10	(Theo. for Wing & Rotor, All Others Exposed)						
11		Speed Brks.	Flaps (L.E.)	Flaps (T.E.)	Slats	Spoilers	Ailerons
12	AREAS - (Sq. Ft.)						
13	BODY & NACELLE GROUPS	Length (Ft.)	Depth (Ft.)	Width (Ft.)	Wetted Area Sq. Ft.	Vol. (Cu. Ft.)	Vol. Press. Cu. Ft.
14	FUSELAGE or HULL						
15	BOOMS						
16	NACELLES						
17							
18							
19	ALIGHTING GEAR GROUP	Length - Oleo Ext.		Oleo Travel		Length - Arrest Hook	
20		Axle to ℄ Trunnion		Ext. to Collapsed		Hook Trunnion to Pt.	
21	LOCATION						
22	DIMENSIONS (Inches)						
23							
24	PROPULSION GROUP						
25	ENGINES	S.L.S. Thrust in Lbs. - Eng. with Afterburner		S.L.S. Thrust in Lbs. Eng. without Afterburner		Max. S.L.S. Shaft HP	Shaft RPM at Max. HP
26	MAIN						
27	AUXILIARY						
28	ROTOR DRIVE SYSTEM	Design H.P.	Input R.P.M.	Output RPM at Rotor	Rated Rotor RPM	Number Gear Boxes	
29							
30		Protected		Unprotected		Integral	
31	FUEL - INTERNAL *** LOCATION	No. Tanks	Gallons	No. Tanks	Gallons	No. Tanks	Gallons
32	WING						
33	FUSELAGE						
34	- EXTERNAL ***						
35							
36	OIL						
37	ELECTRICAL & LOAD & HANDLING GROUPS	Num. Main Generators	Generator Output DC	Generator Output AC		Cargo Floor Area	
38							
39							
40	STRUCTURAL DATA - CONDITION	Body Plus Int. Content Lbs.	External Wt. on Body	Fuel in Wings Lbs.		Design Gross Weight	Ult. L.F.
41	FLIGHT - MANEUVER						
42	- GUST						
43	LANDING						
44							
45	MAX. GROSS WITH ZERO WING FUEL						
46	CATAPULTING						
47	LIMIT LANDING SINK SPEED (Ft./Sec.)						
48	Lift Assumed for Landing Design Condition (% W)						
49	STALL SPD. - LDG. CONFIG. - POWER OFF						
50	Pressurized Cabin - Ult. Design Press. Differential Flight P.S.I.						
51	ROTOR TIP SPD AT DESIGN LIMIT	R.P.M.	Power	Ft./Sec.	Corresponding Design Factor		
52							
53	% DESIGN LOAD	Wing		Rotor		Rotor	
54	DESIGN SPEED AT S.L. (Knots)	Level		Dive			
55	DESIGN SPD. AT OTHER ALTITUDES		Alt.		Alt.		
56							
57	DCPR WEIGHT (Airframe)						

*Nose to aft tip of fuselage (excluding equipment protuberances)
**Parallel to ℄ or ℄ Aircraft for Wing & Tail. Insert inches from ℄ Rotor for Rotors.
***Total Usable Capacity.
****Insert inches from ℄ Rotor to Blade Attachment for Rotors.

MIL-STD-1374 PART I

GROUP WEIGHT STATEMENT

Name ________________
Date ________________

Page ________________
Model ________________
Report ________________

AIRFRAME WEIGHT

The Airframe Weight to be entered on line 57 of page 5 of the Group Weight Statement should be derived here in detail showing those items deducted from weight empty as required by the document "Cost Information Reports (CIR) for Aircraft, Missiles, and Space Systems" dated 21 April, 1966, or subsequent revisions thereto. Airframe weight is the same as previously called AMPR andDCPR and is not to be confused with "Work Breakdown Structure (WBS) Airframe Cost Definition."

WEIGHT EMPTY ________________
DEDUCT THE FOLLOWING ITEMS
(ITEMIZE)
____
____
____
____
____

AIRFRAME WEIGHT ________________

4.12 PERFORMANCE CALCULATIONS SUBPROGRAM

The flow chart of the control loop for the performance calculations subprogram is shown in Figure 4-48. This routine monitors the flow during calculation of mission performance data and calculates the total fuel required at the end of the mission.

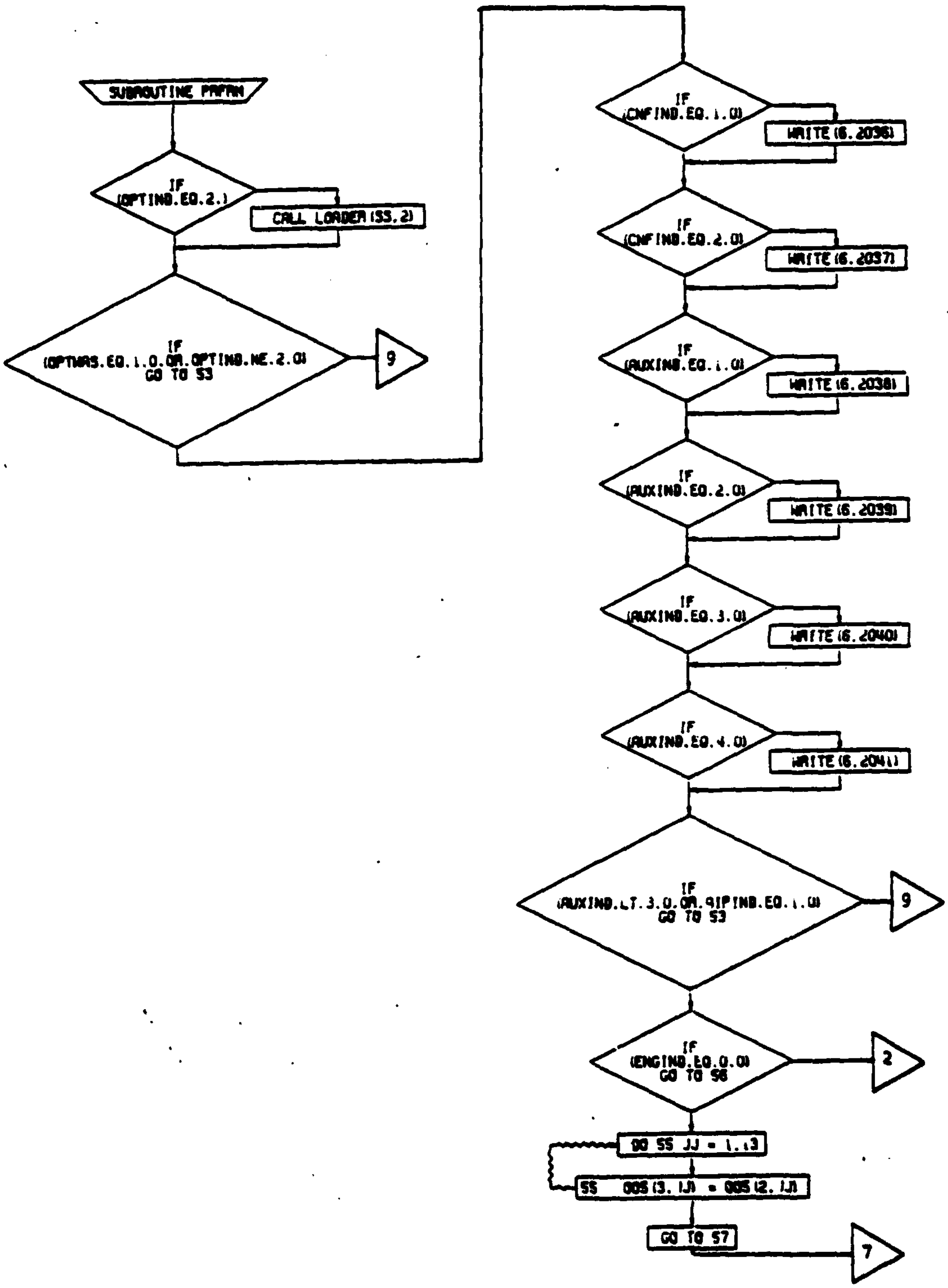


Figure 4-48. PRFRM Subroutine, Flow Chart (Part 1 of 6)

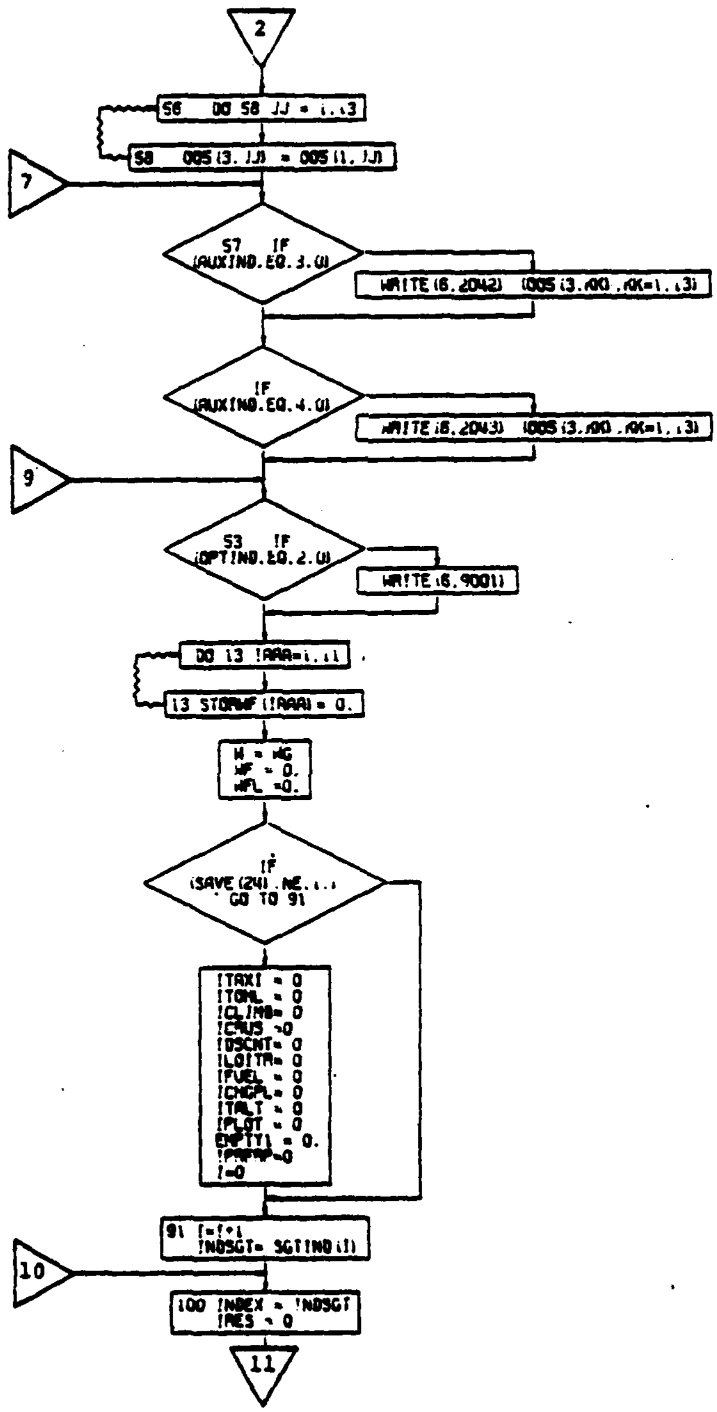


Figure 4-48. PRFRM Subroutine, Flow Chart (Part 2 of 6)

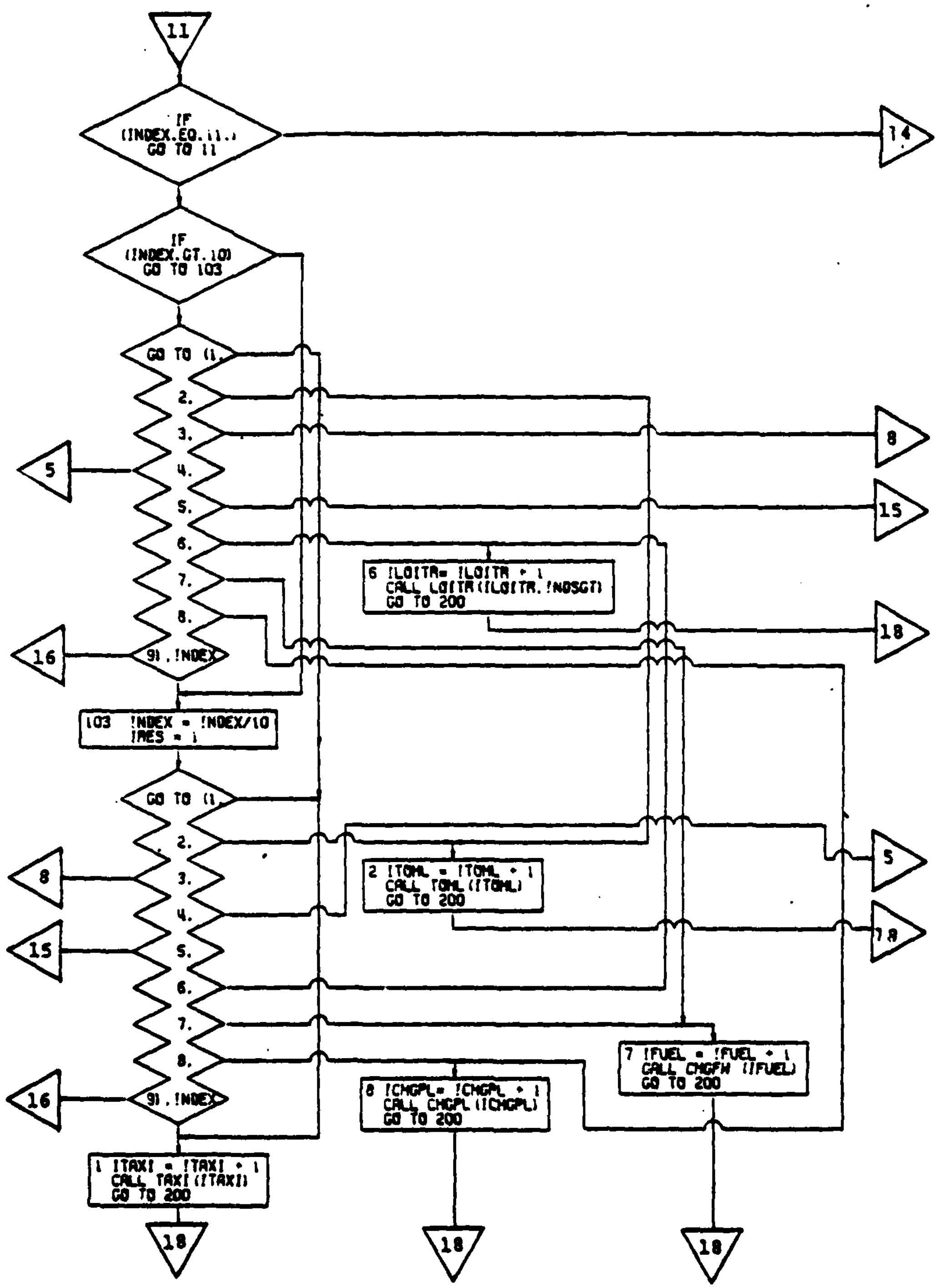


Figure 4-48. PRFRM Subroutine, Flow Chart (Part 3 of 6)

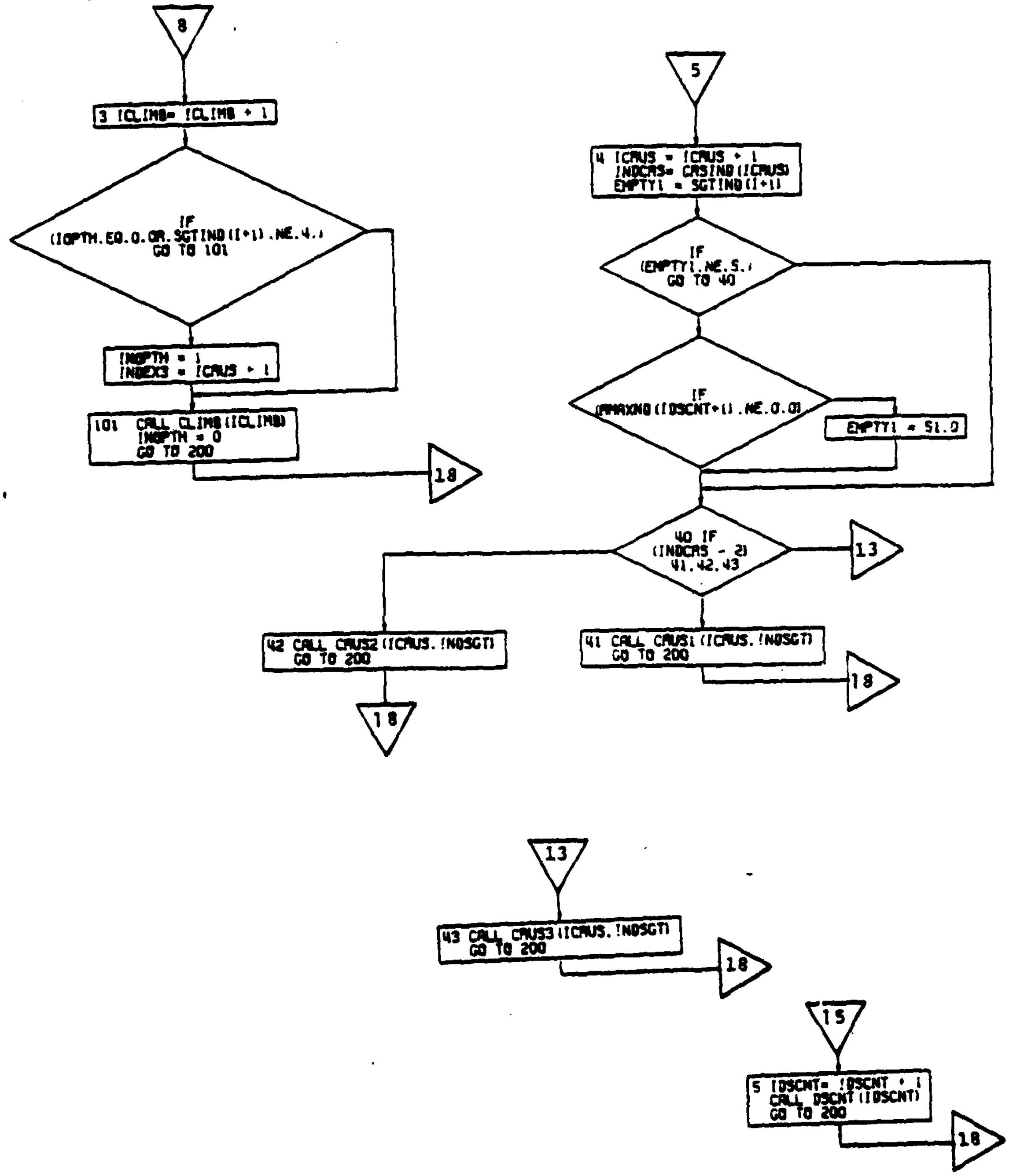


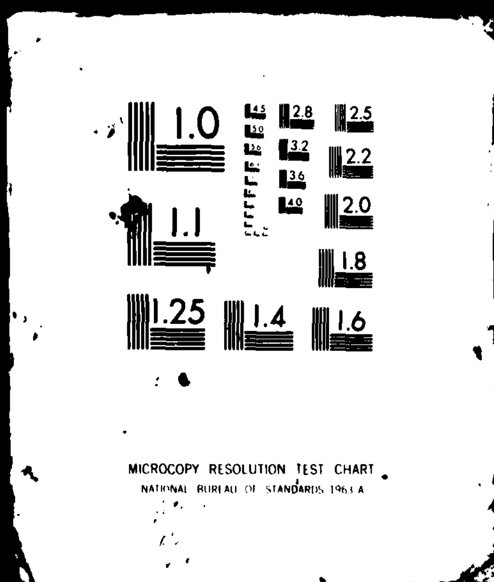
Figure 4-48. PRFRM Subroutine, Flow Chart (Part 4 of 6)

AD-A113 037 BOEING VERTOL CO PHILADELPHIA PA F/G 9/2
HESCOMP. THE HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM--ETC(U)
OCT 79 S J DAVIS, H ROSENSTEIN, K A STANZIONE N62269-79-C-0217
UNCLASSIFIED D210-10699-2-REV-2. NADC-78265-60 NL

4 9

4 OF 9

AD-A113037



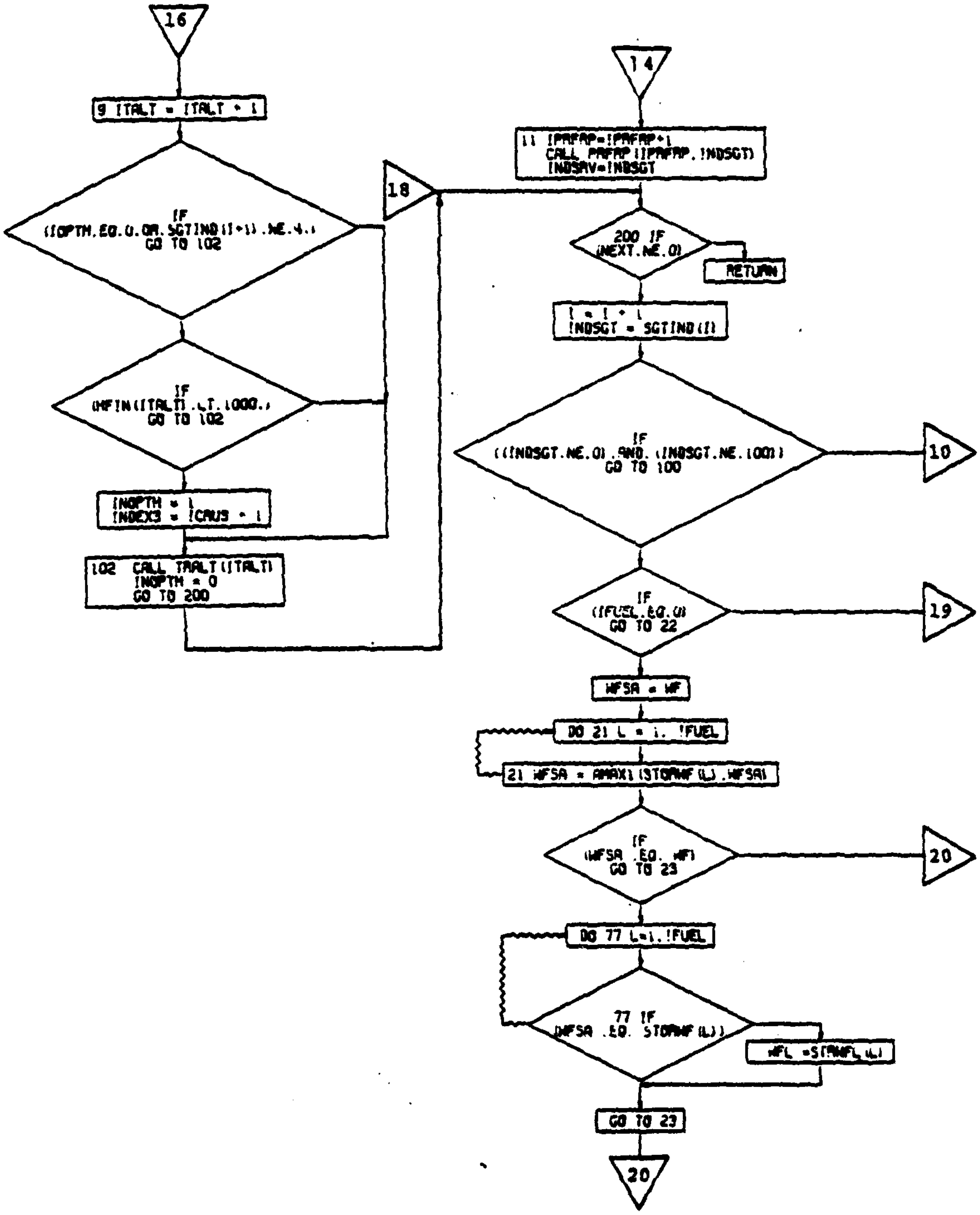


Figure 4-48. PRFRM Subroutine, Flow Chart (Part 5 of 6)

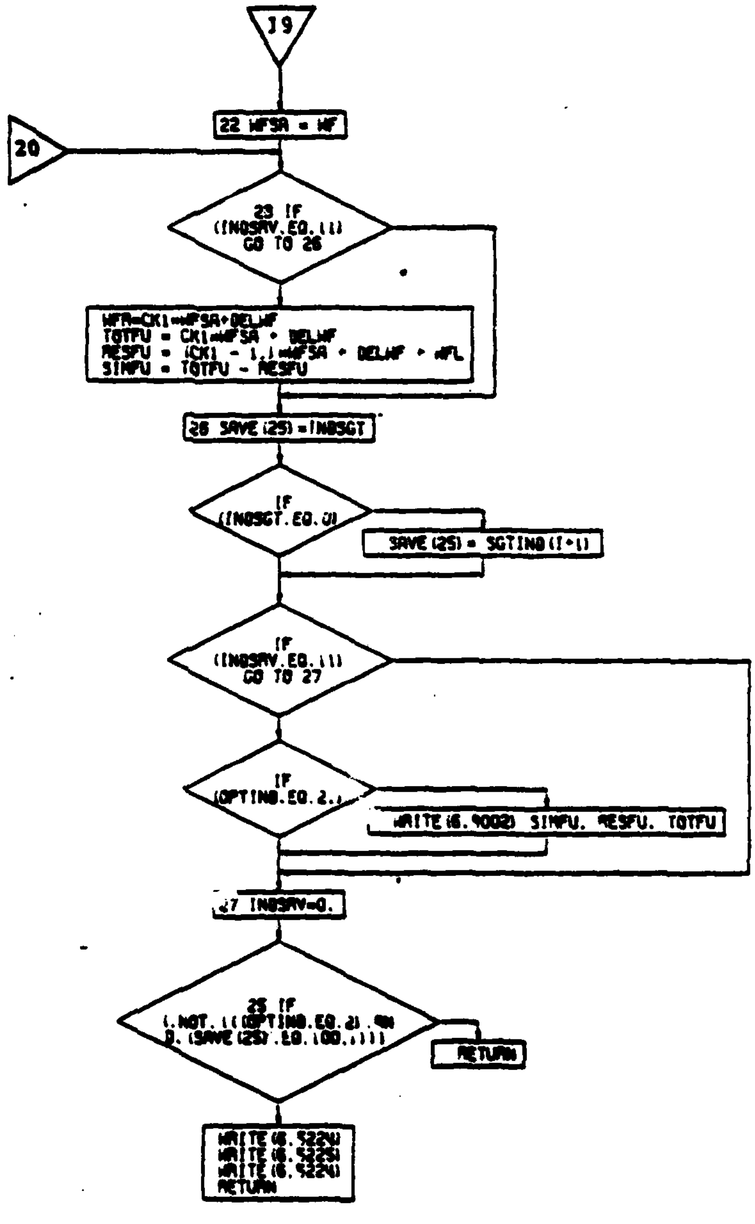


Figure 4-48. PRFRM Subroutine, Flow Chart (Part 6 of 6)

4.12.1 Taxi Calculations Subroutine

The taxi calculations subroutine (specified by SGTIND = 1), calculates the fuel required to taxi at ground idle engine setting for a specified period of time. For aircraft which have independent auxiliary cruise propulsion systems (AIPIND = 2), the program will calculate taxi performance for either primary engines operating alone, or both primary and auxiliary cruise propulsion engines operating. This is accomplished by means of the input constant k_{FI}. If $k_{FI} = 0$, the program will consider only primary engines in operation in determining fuel flow rates. If $k_{FI} = 1$, the program will include both primary and lift propulsion systems in calculating the fuel flow rates and the corresponding reduction in aircraft gross weight. Figure 4-49 is a flow chart of this subroutine.

Input to this subroutine consists of the time for taxi, value of k_{FI}, and atmospheric conditions.

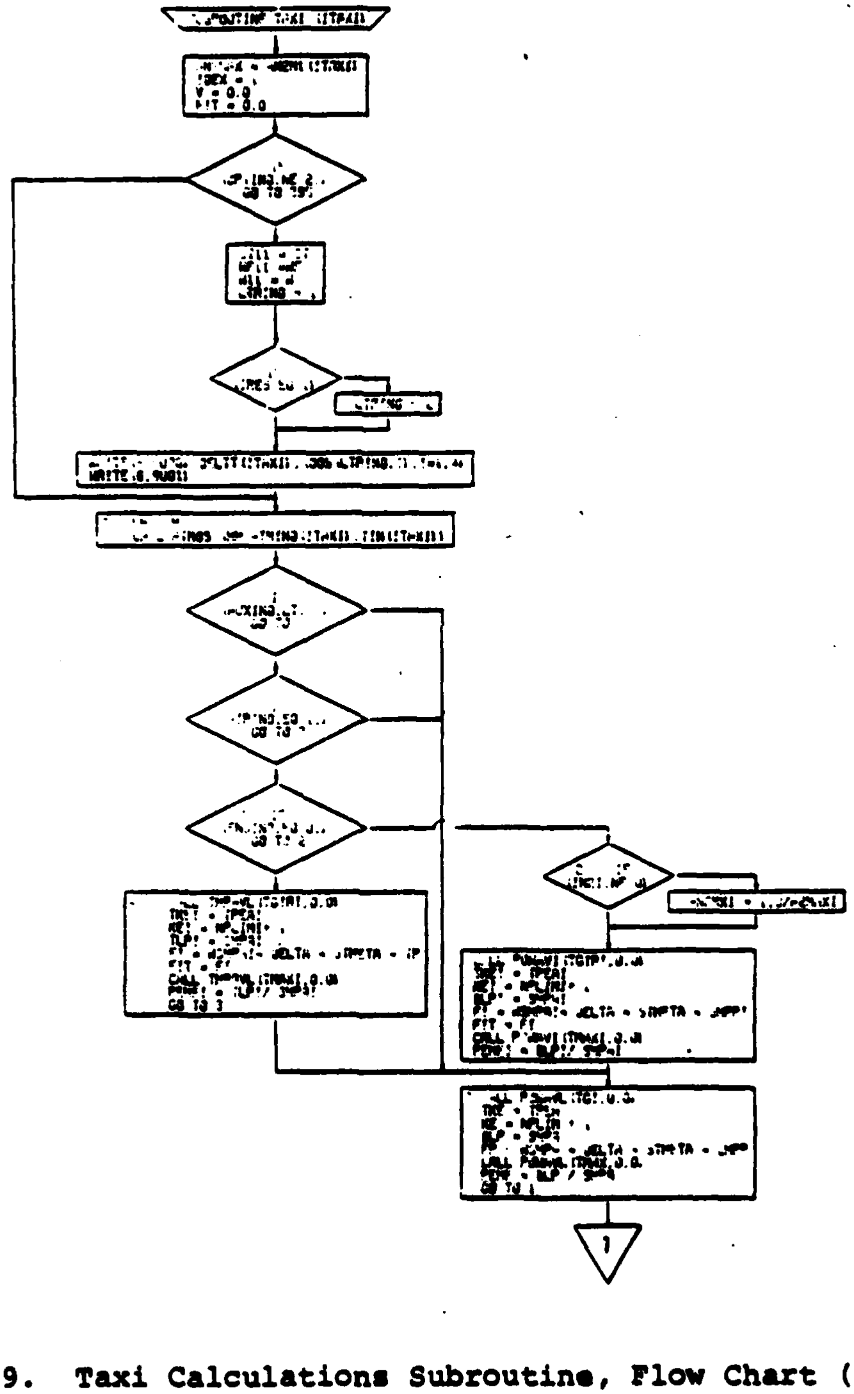


Figure 4-49. Taxi Calculations Subroutine, Flow Chart (Part 1 of 2)

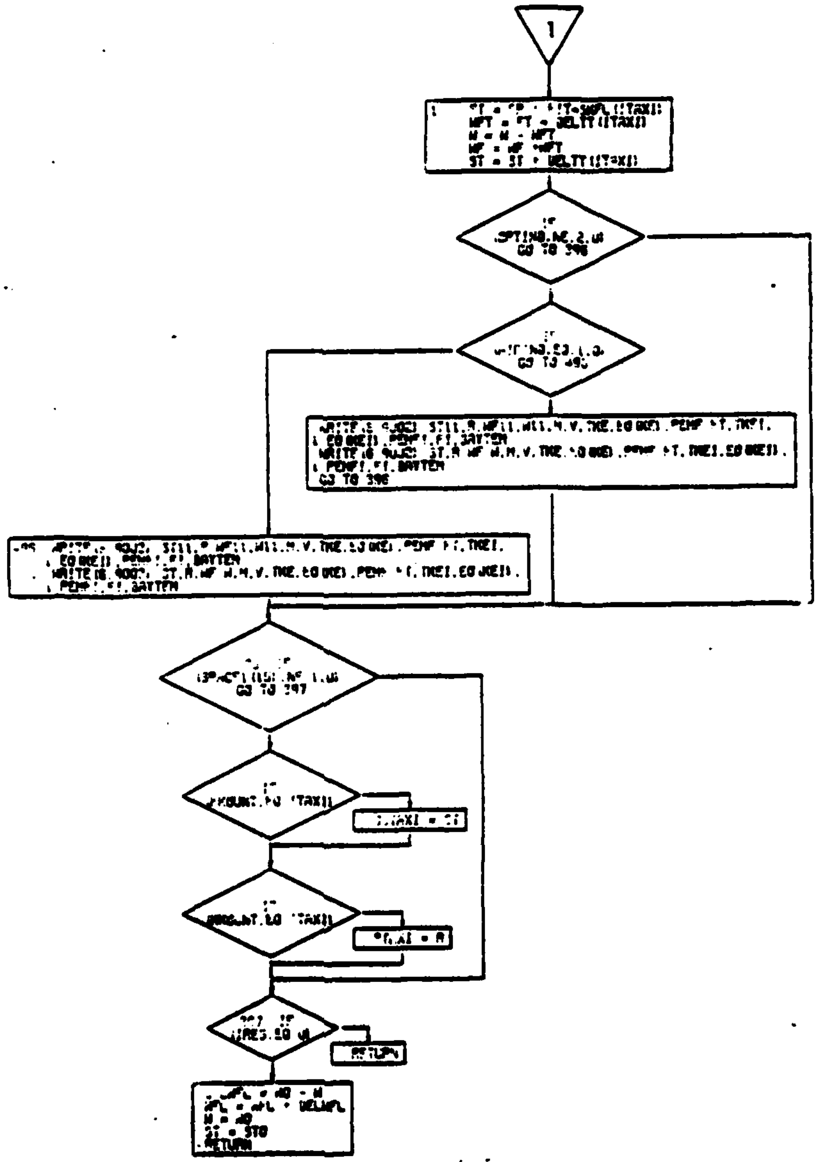


Figure 4-49. Taxi Calculations Subroutine, Flow Chart (Part 2 of 2)

4.12.2 Takeoff, Hover, and Landing Calculations Subroutine

The takeoff, hover, and landing calculations subroutine (specified by SGTIND = 2) will calculate the thrust or power required and corresponding fuel flow rates during simulated takeoff/hover/landing operations. Four options are available, specified by the input indicator TOLIND:

TOLIND = 1 - Input required thrust-weight ratio and vertical rate of climb. Program will calculate required power fractions.

TOLIND = 2 - Input the required power fraction and vertical rate of climb. Program will calculate thrust-weight ratio.

TOLIND = 3 - This option is the same as TOLIND = 1, except hover in ground effect is assumed, requiring the input of height of fuselage bottom above ground as a fraction of main rotor diameter.

TOLIND = 4 - This option is the same as TOLIND = 2, except hover in ground effect is assumed, requiring the input of height of fuselage bottom above ground as a fraction of main rotor diameter.

In all cases, the program will print out the power fraction and thrust-weight ratio. The program will permit operation at power fractions greater than 1.0 (more than 100 percent of available power) in order to make it easier to perform studies in which engine power is being varied parametrically to satisfy specified takeoff or landing requirements as a site. The program will, however, print a cautionary note that power fraction exceeds 100 percent. In the case (TOHL = 2 or 4) where the required power fraction is input, if the calculated thrust-weight ratio is less than the design thrust-weight ratio input (LOC 0228), the following cautionary note will be printed: INSUFFICIENT POWER AVAILABLE TO HOVER. T/W AVAILABLE LESS THAN T/W REQUIRED AT DESIGN DOWNLOAD.

For a helicopter configuration having auxiliary independent engines, the program sets the auxiliary engine power setting at ground idle.

It is possible to use a hover segment in the mission profile to account for a reserve fuel requirement (SGTIND = 20), in such a case the helicopter weight at the end of hover is set back to the weight at the beginning of hover, or as a part of the basic mission (in this case the weight is not reset). In either case, the fuel used during hover is included in the total fuel required to size the helicopter.

Figure 4-50 is a flow chart for this subroutine.

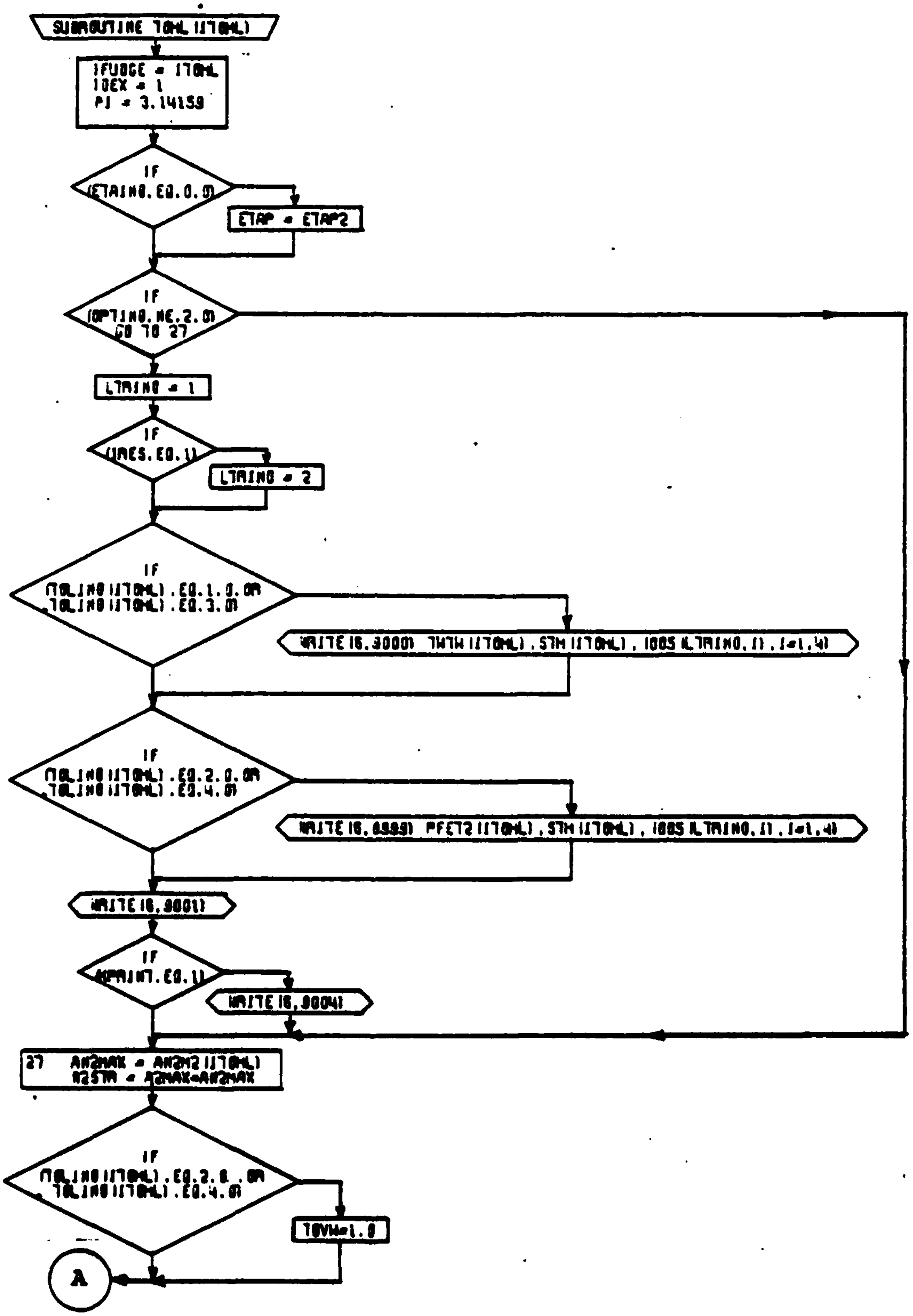


Figure 4-50. Takeoff, Hover, and Landing Subroutine Flow Chart (Part 1 of 4).

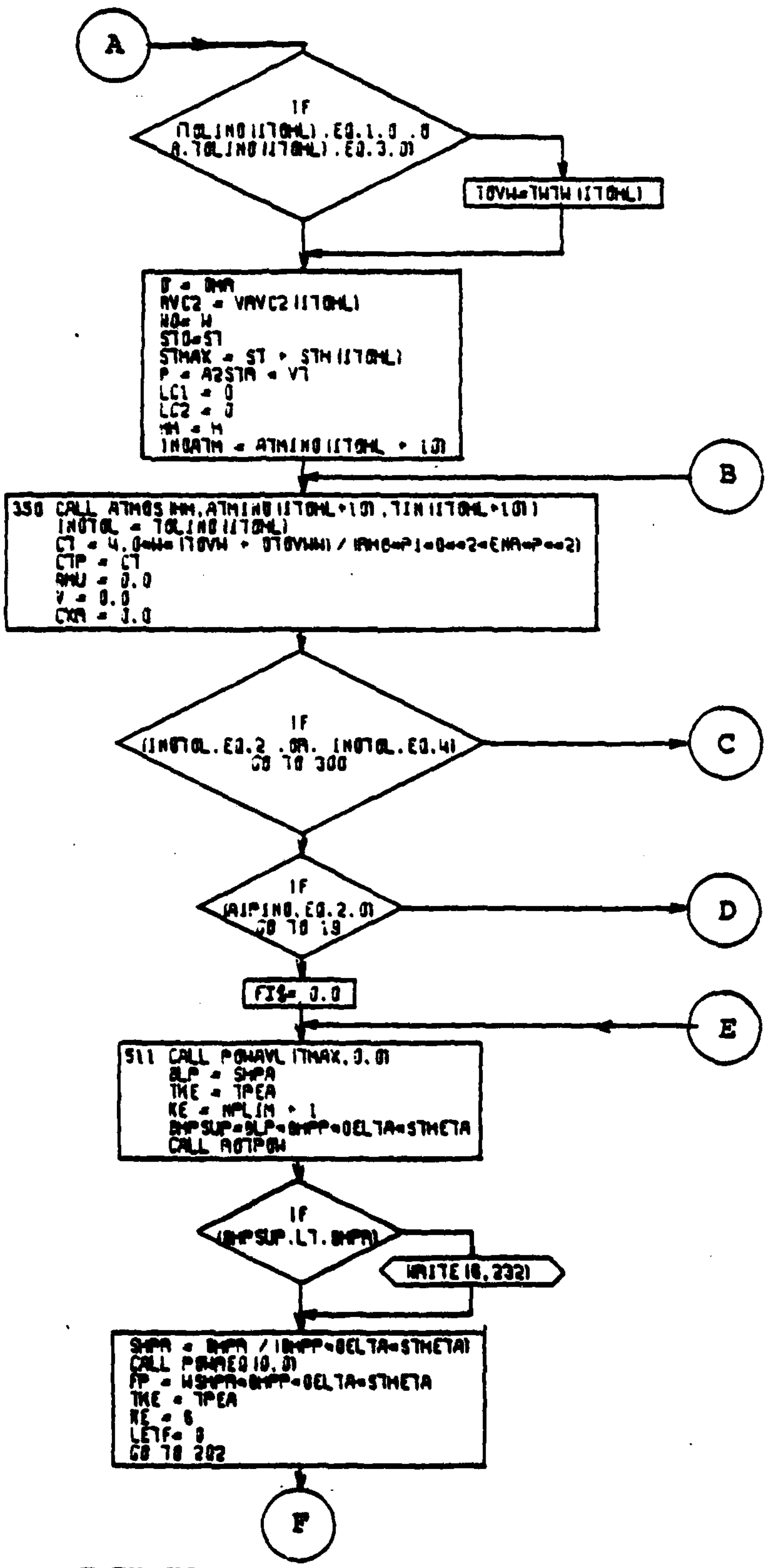


Figure 4-50. Takeoff, Hover, and Landing Subroutine Flow Chart (Part 2 of 4).

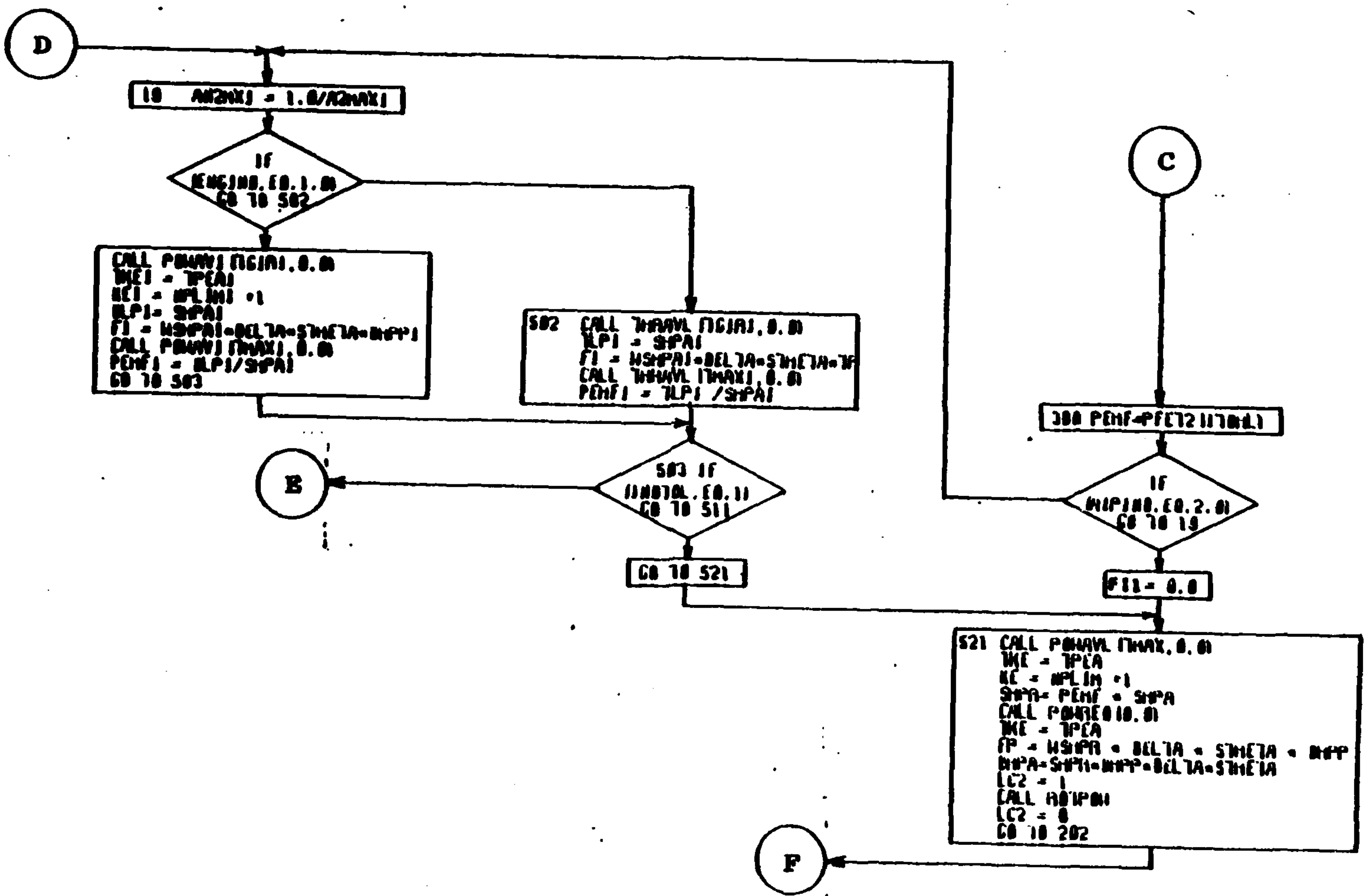


Figure 4-50. Takeoff, Hover, and Landing Subroutine Flow Chart (Part 3 of 4).

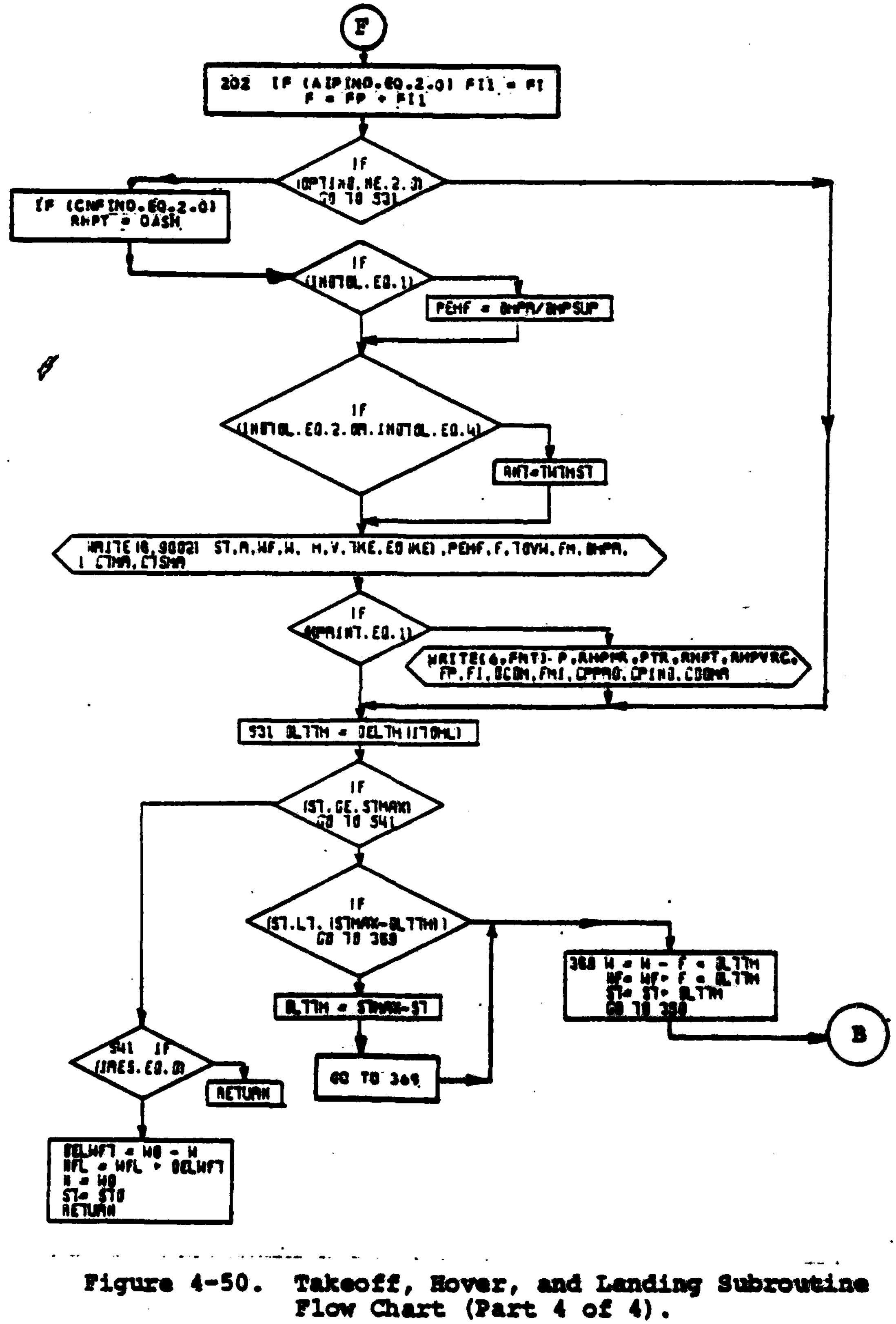


Figure 4-50. Takeoff, Hover, and Landing Subroutine Flow Chart (Part 4 of 4).

4.12.3 Climb Calculations Subroutine

The third performance segment is a calculation of climb performance. Four options are available, specified by the indicator CLMIND:

CLMIND = 1 - The program calculates performance of the aircraft in a maximum rate of climb ascent limited by maximum operating airspeed and maximum operating Mach number. In no event will the aircraft be required to fly at an airspeed greater than the input maximum operating airspeed.

CLMIND = 2 - The program calculates the climb performance of the aircraft at specified constant equivalent airspeed limited, as before, by M_{MO} and V_{MO}.

CLMIND = 3 - Climb performance is calculated at constant specified Mach number. Otherwise, the option is similar to CLMIND = 2.

CLMIND = 4 - Climb will be calculated at constant true airspeed with the same constraints as for CLMIND = 2.

For all options, the user may input the power setting of the engines which will be considered to be the maximum permissible rating. This is accomplished by means of the indicator POWIND:

$$\left.\begin{array}{l}\text{POWIND = 0: Maximum}\\ \text{POWIND = 1: Military}\\ \text{POWIND = 2: Normal}\end{array}\right\}\text{engine rating}$$

The user may specify a value for incremental equivalent flat plate area parasite drag during climb, ΔFe_{CLIMB}, to represent variations in store drag.

Engine shutdown during climb may be simulated by inputs for N_{PSD} (primary engines) and N_{PSDI} (auxiliary independent engines). One or more engines may be shutdown.

If the flight path (climb) angle exceeds 90 degrees, the engine power setting is reduced and the program prints out:

CAUTION: CLIMB ANGLE TOO LARGE DUE TO EXCESSIVE POWER AVAILABLE AT THIS FLIGHT CONDITION. POWER SETTING REDUCED TO _____ ENGINE RATING.

If there is insufficient power available for climb, the engine power setting is increased and the program prints out:

CAUTION: INSUFFICIENT POWER AVAILABLE FOR CLIMB AT THIS FLIGHT CONDITION. POWER SETTING INCREASED TO _______ ENGINE RATING.

The input h_{max} has two applications. If h_{OPTIND} = 1 (optimum altitude search) and the *climb is followed by a cruise*, the input value of h_{max} will be interpreted as the maximum flight altitude for the following cruise. If the optimum cruise altitude is determined by the program to be at an altitude less than h_{max}, the climb will terminate at the lower altitude. If an optimum altitude search is not being used or if the following segment is other than a cruise, the input h_{max} is interpreted as the final altitude for the climb segment.

It is possible to use a climb segment in the mission profile to account for a reserve fuel requirement (SGTIND = 30) (in such a case the helicopter weight at the end of climb is set back to the weight at the beginning of climb) or as a part of the basic mission (in this case the weight is not reset). In either case, the fuel used during climb is included in the total fuel required to size the helicopter.

Figure 4-51 is a flow chart for this subroutine.

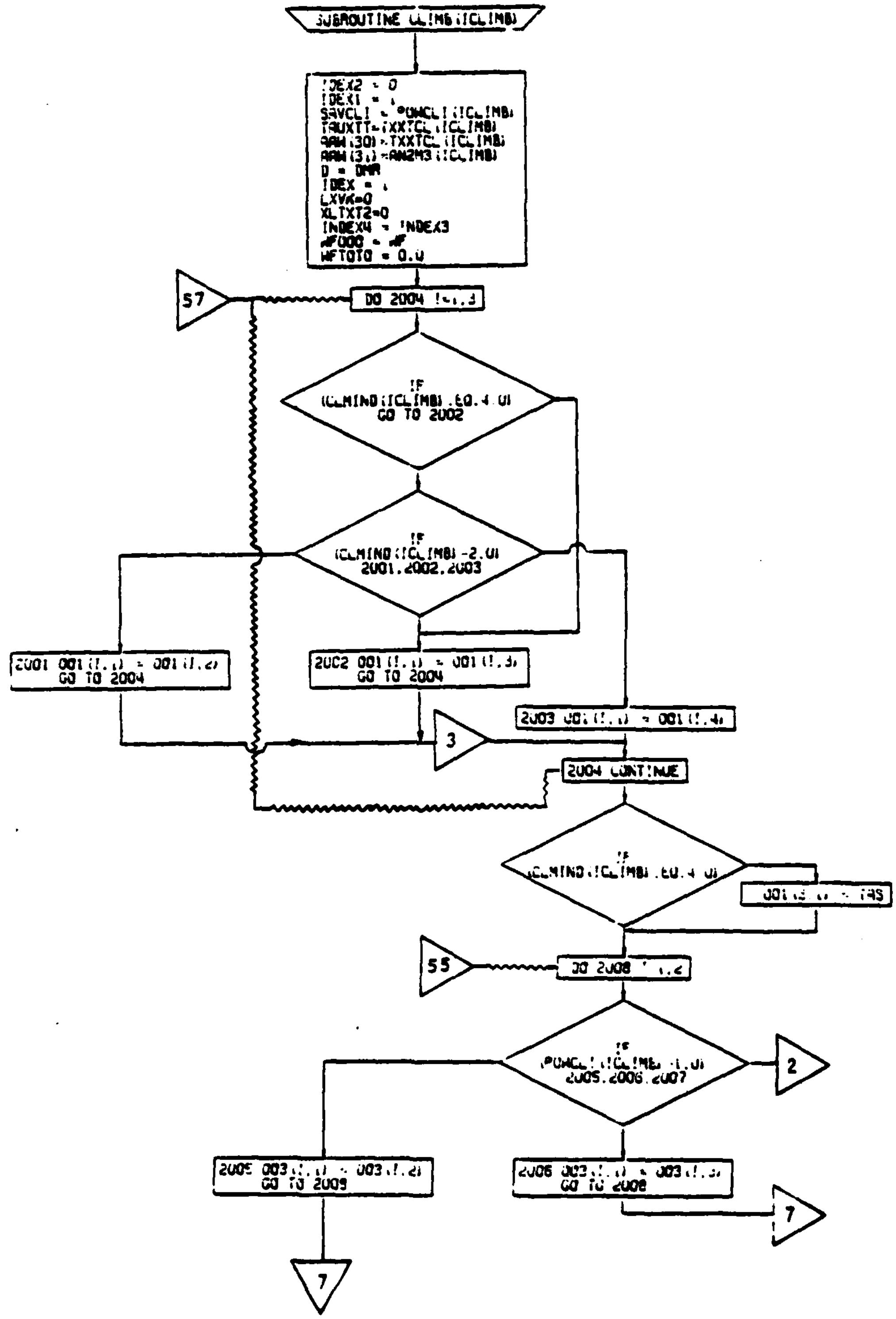


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 1 of 15)

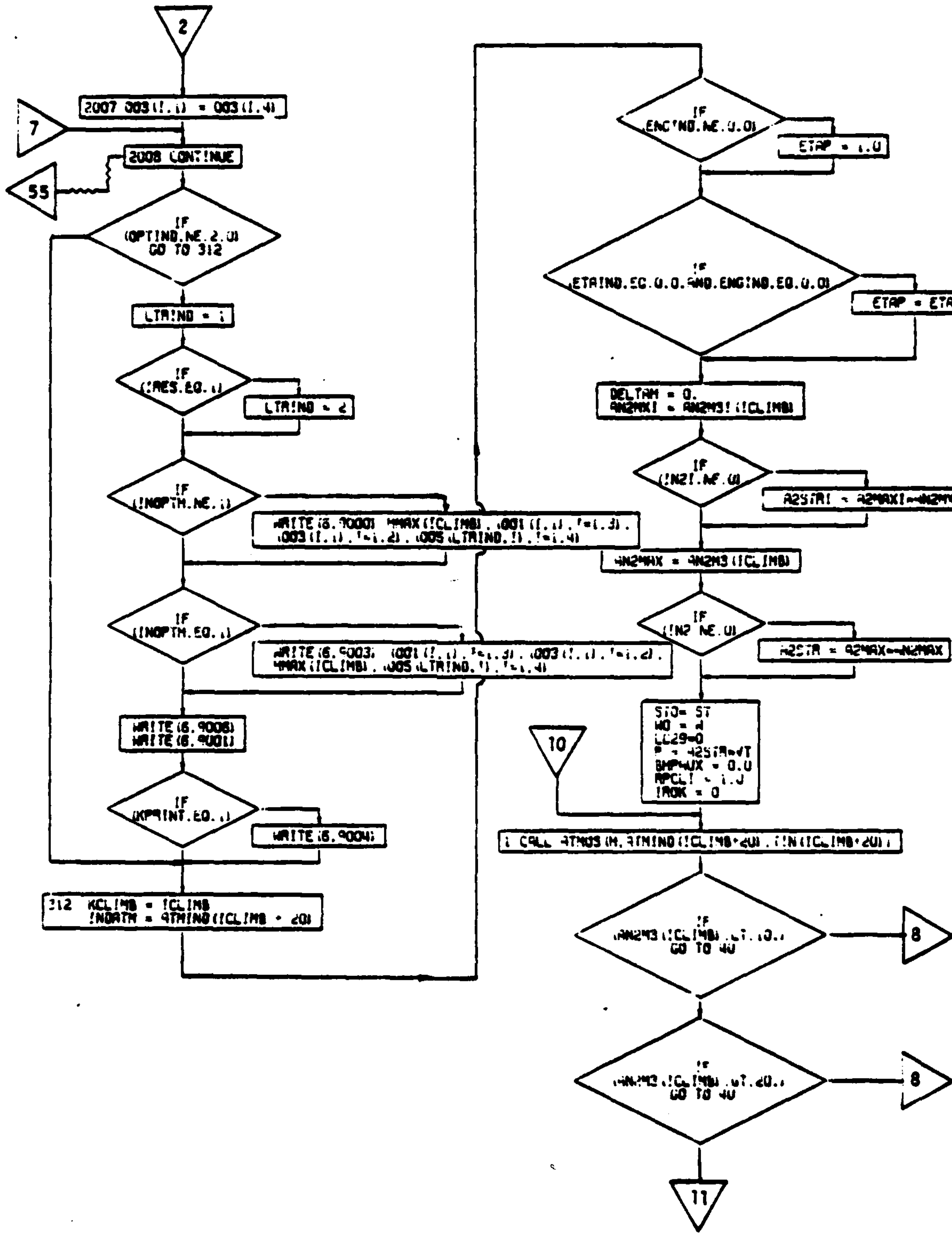


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 2 of 15)

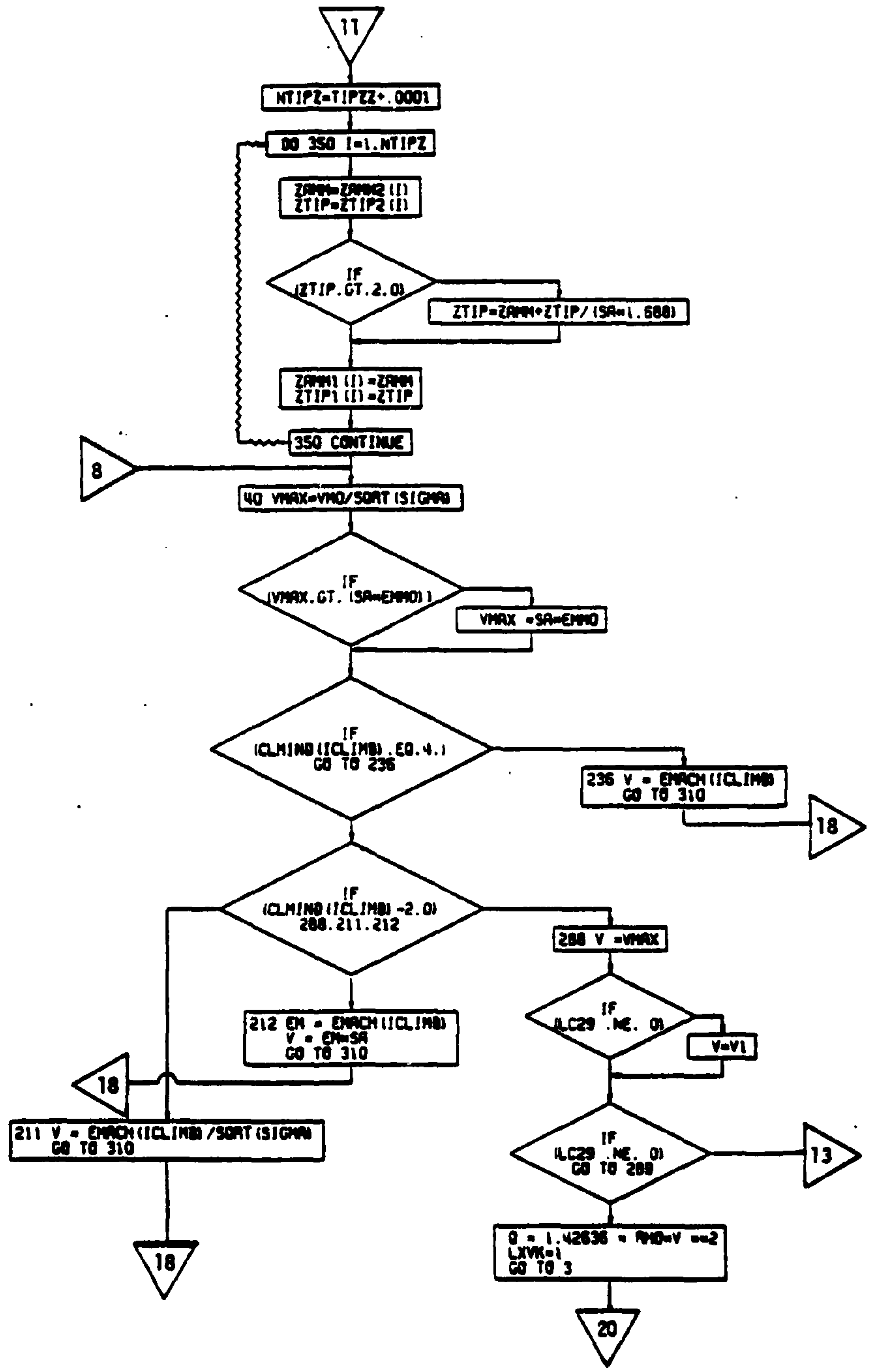


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 3 of 15)

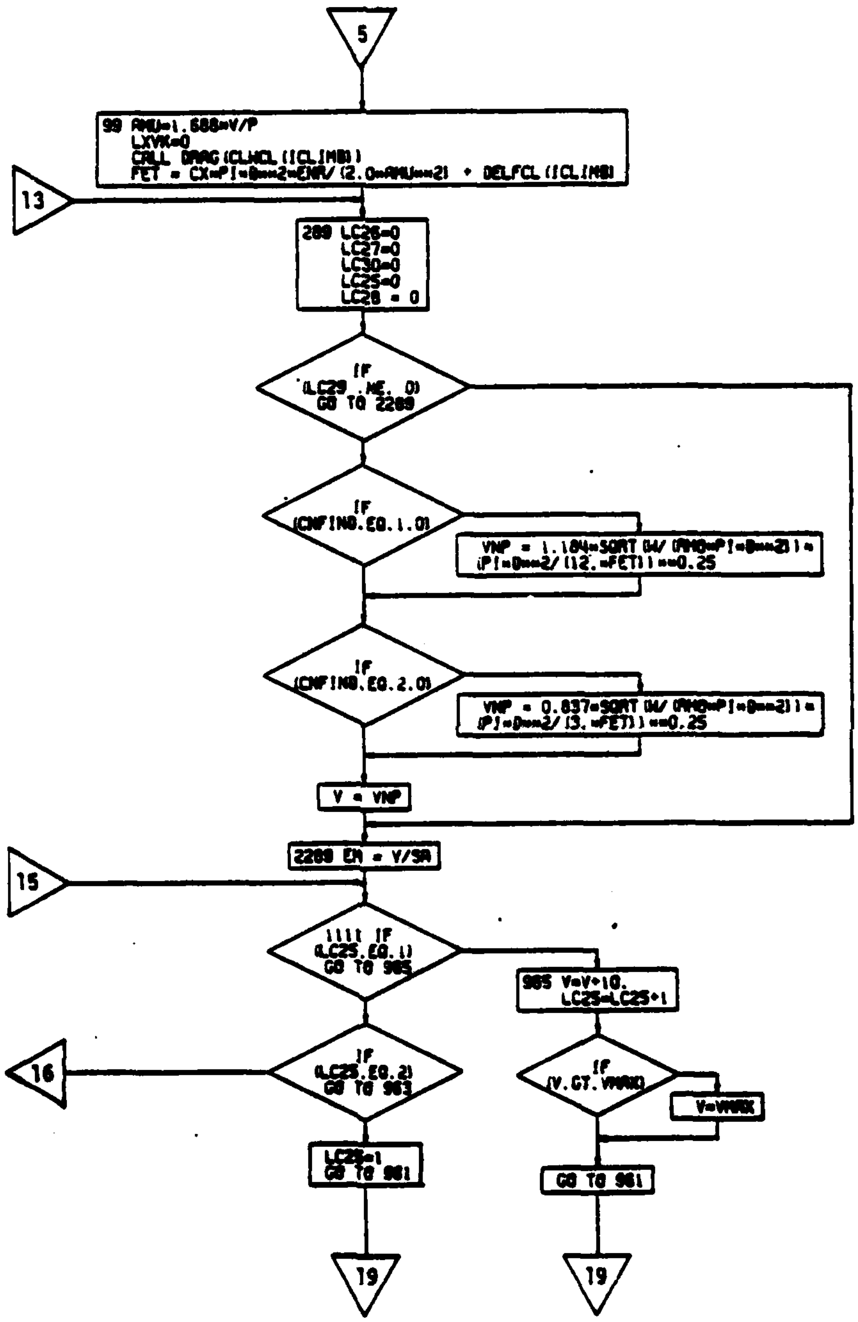


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 4 Of 15)

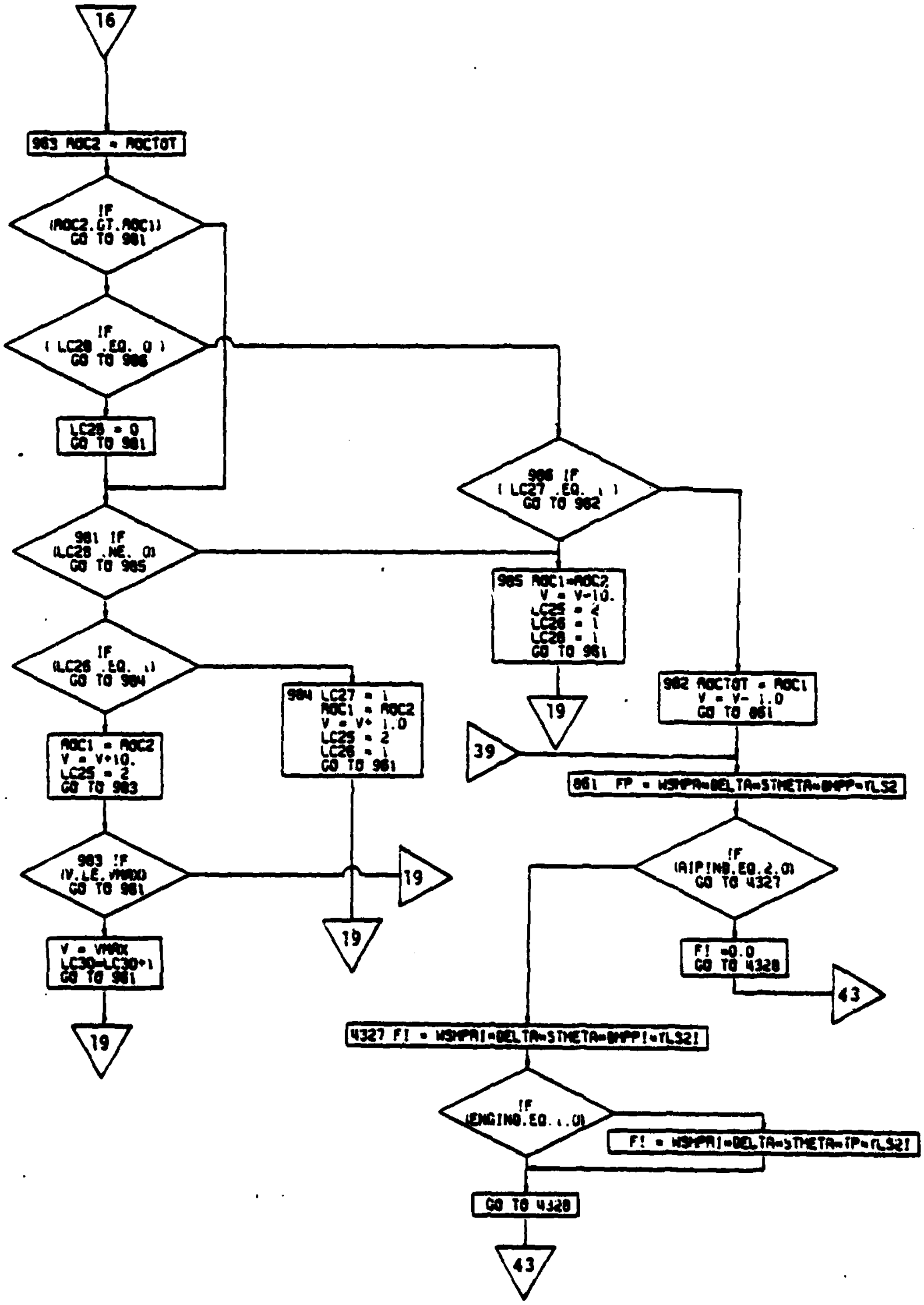


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 5 of 15)

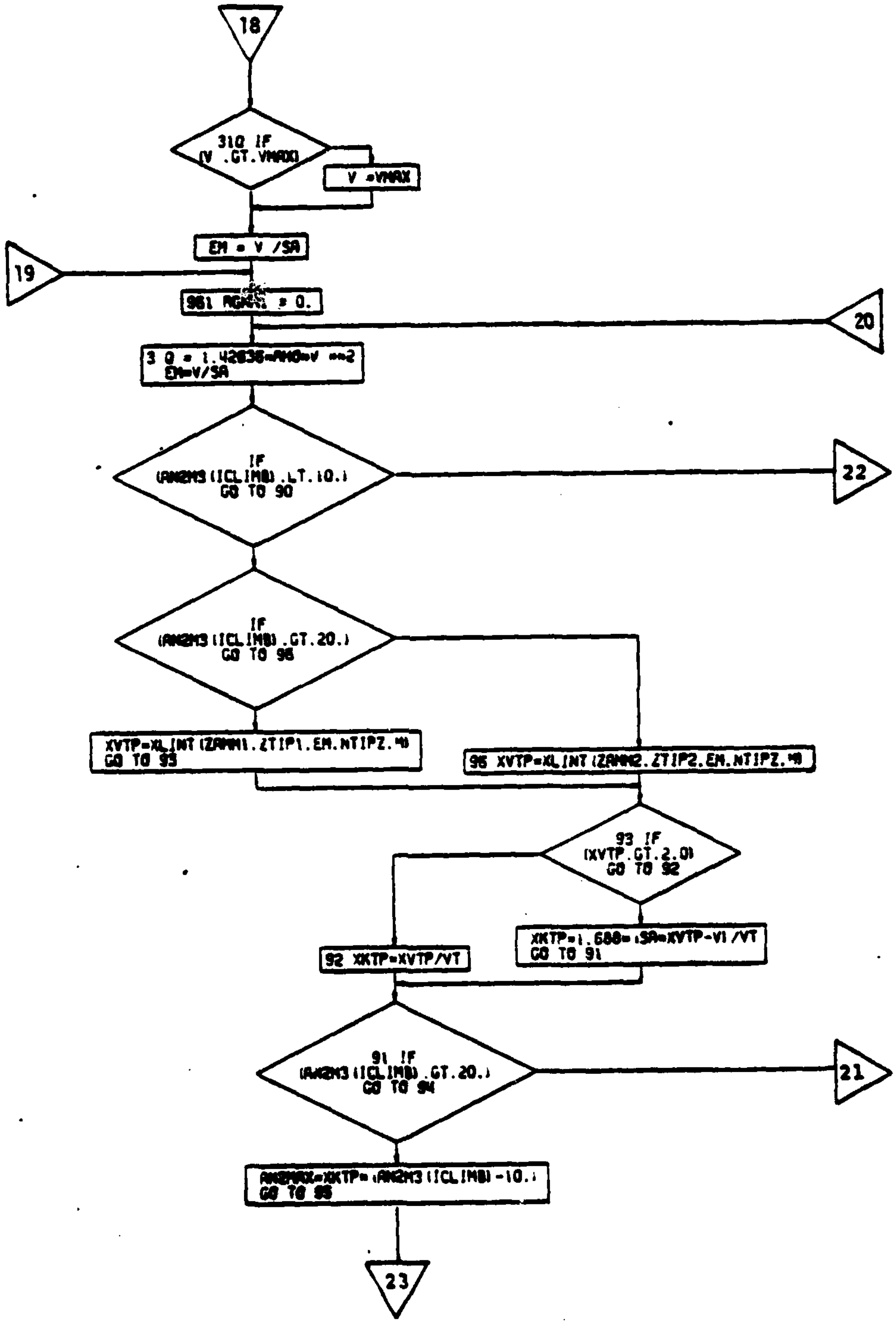


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 6 of 15)

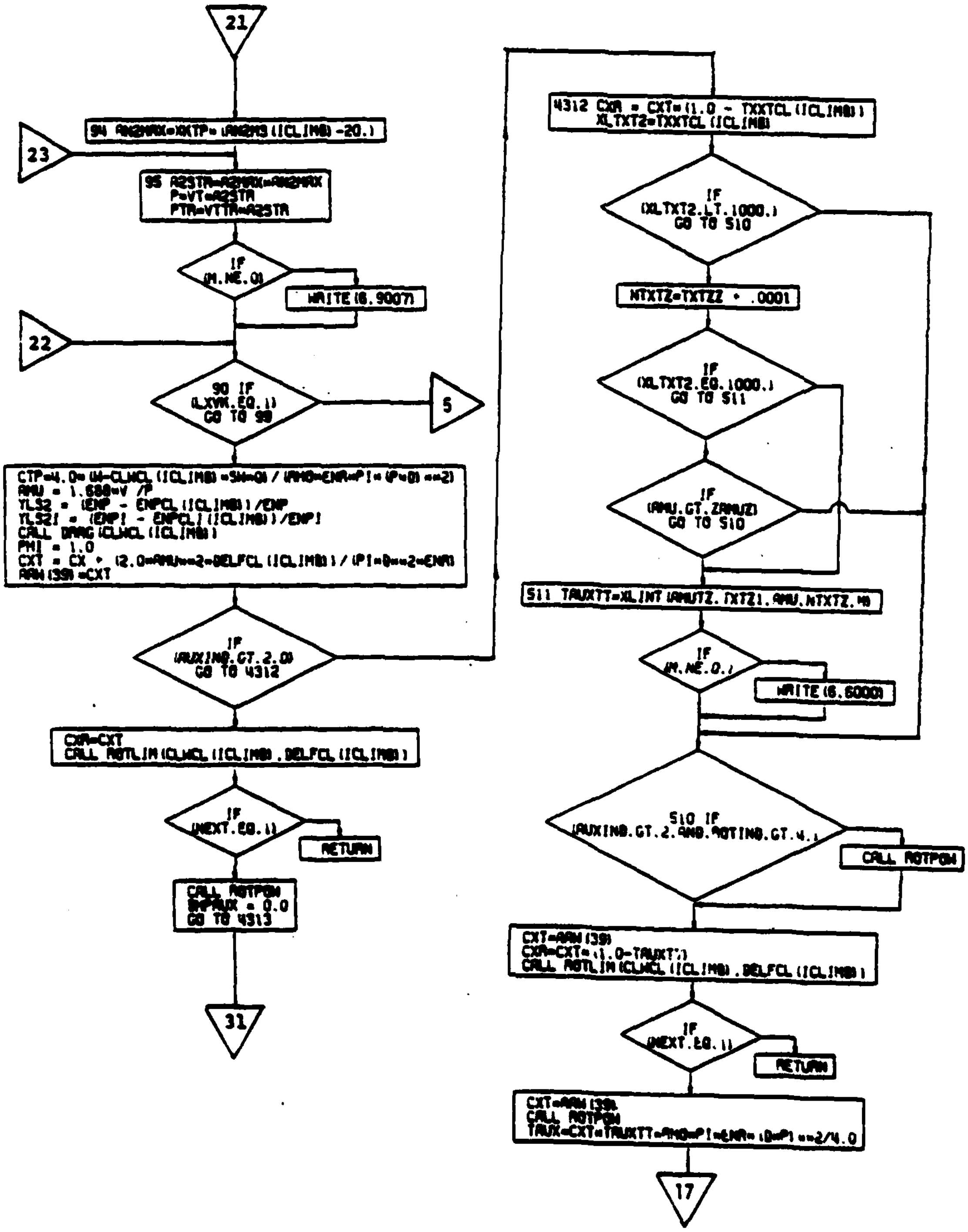


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 7 of 15)

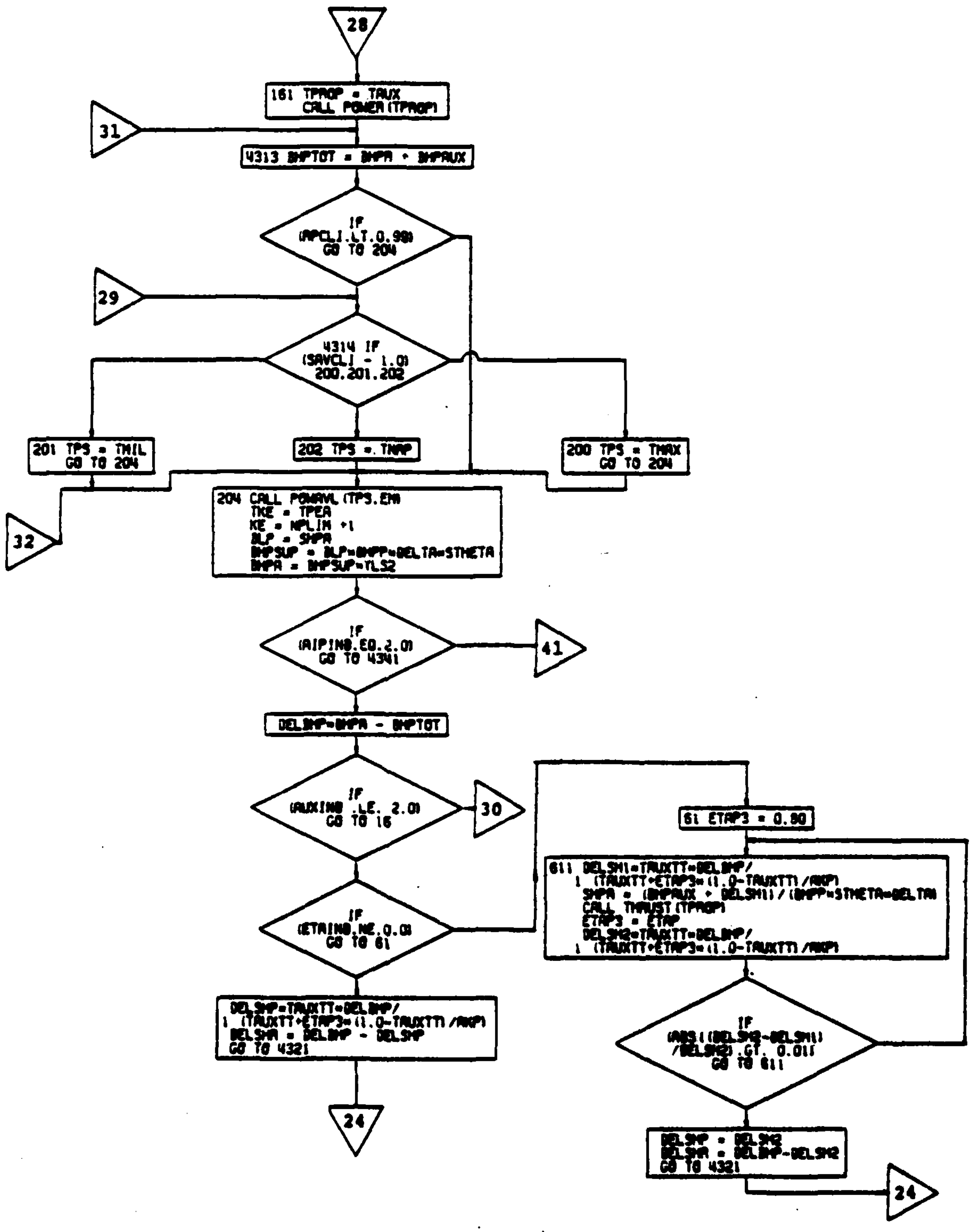


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 8 of 15)

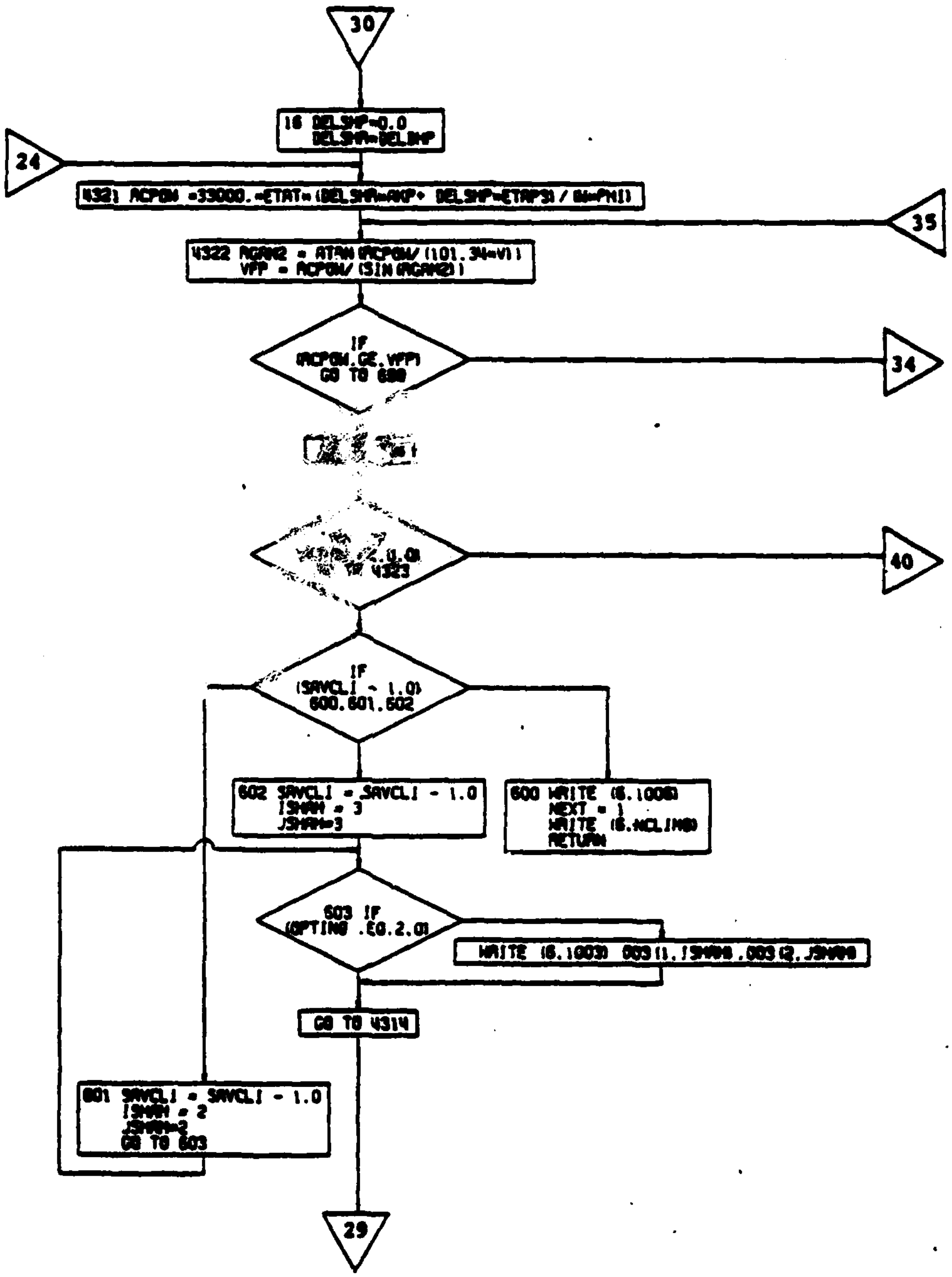


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 9 of 15)

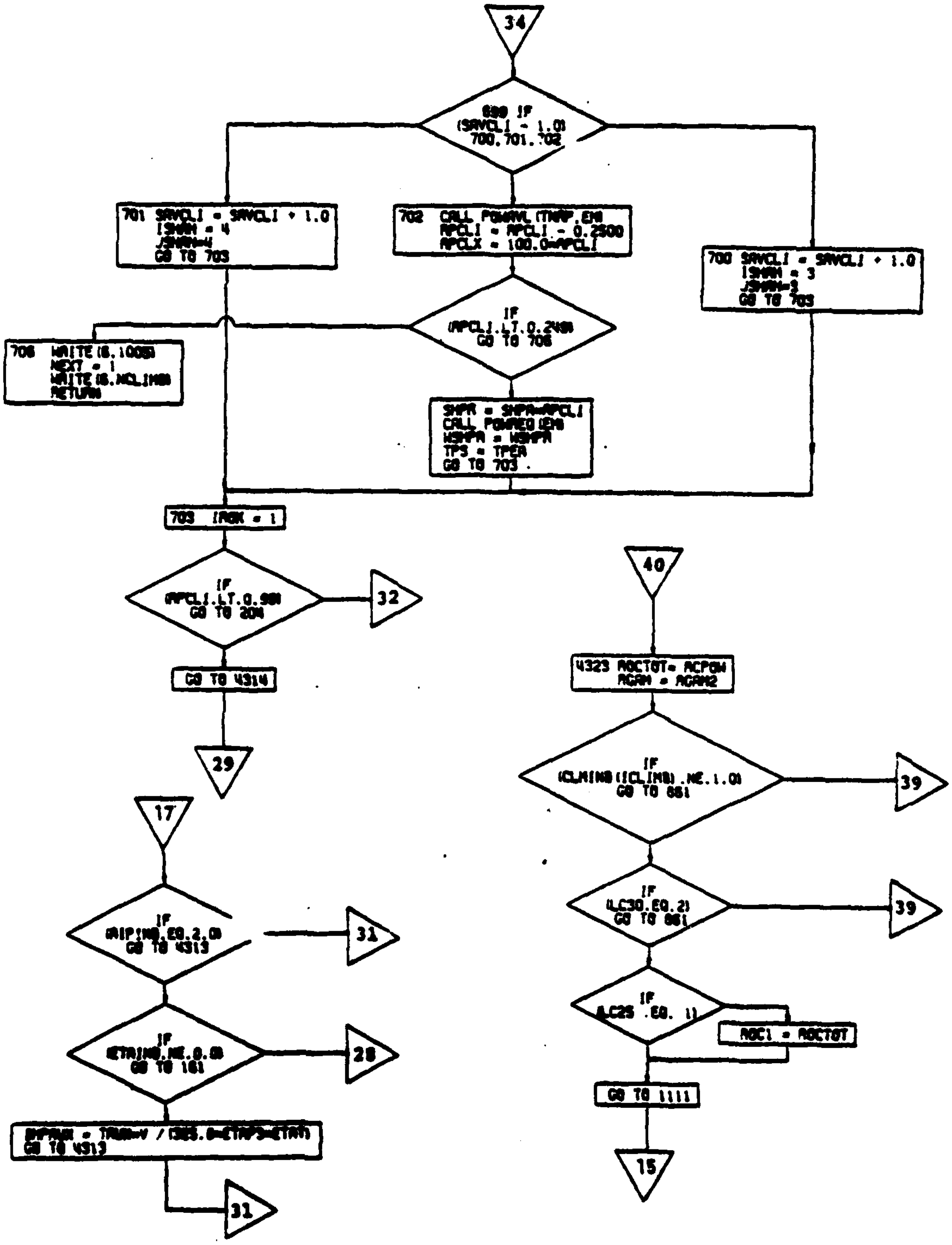


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 10 of 15)

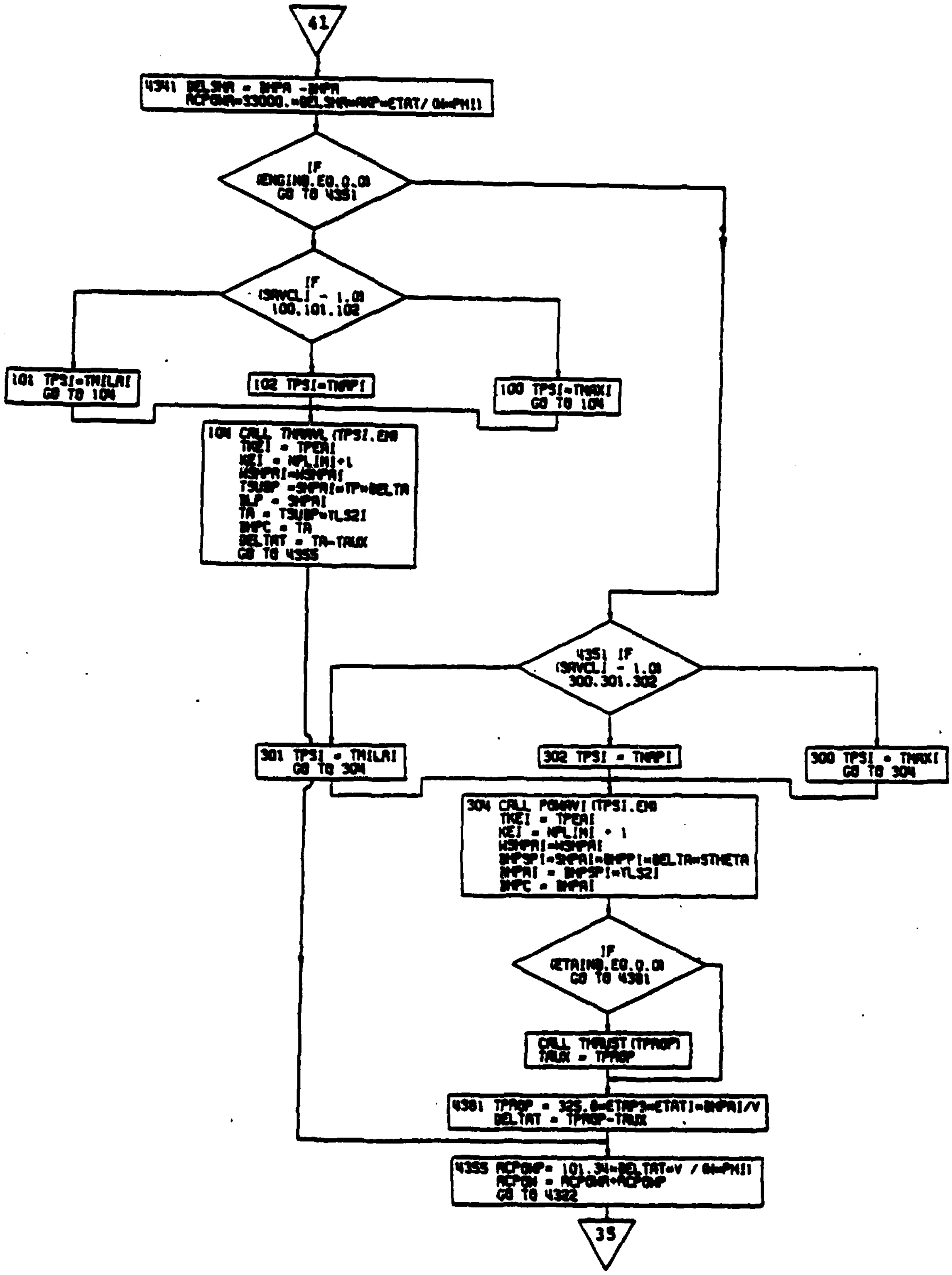


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 11 of 15)

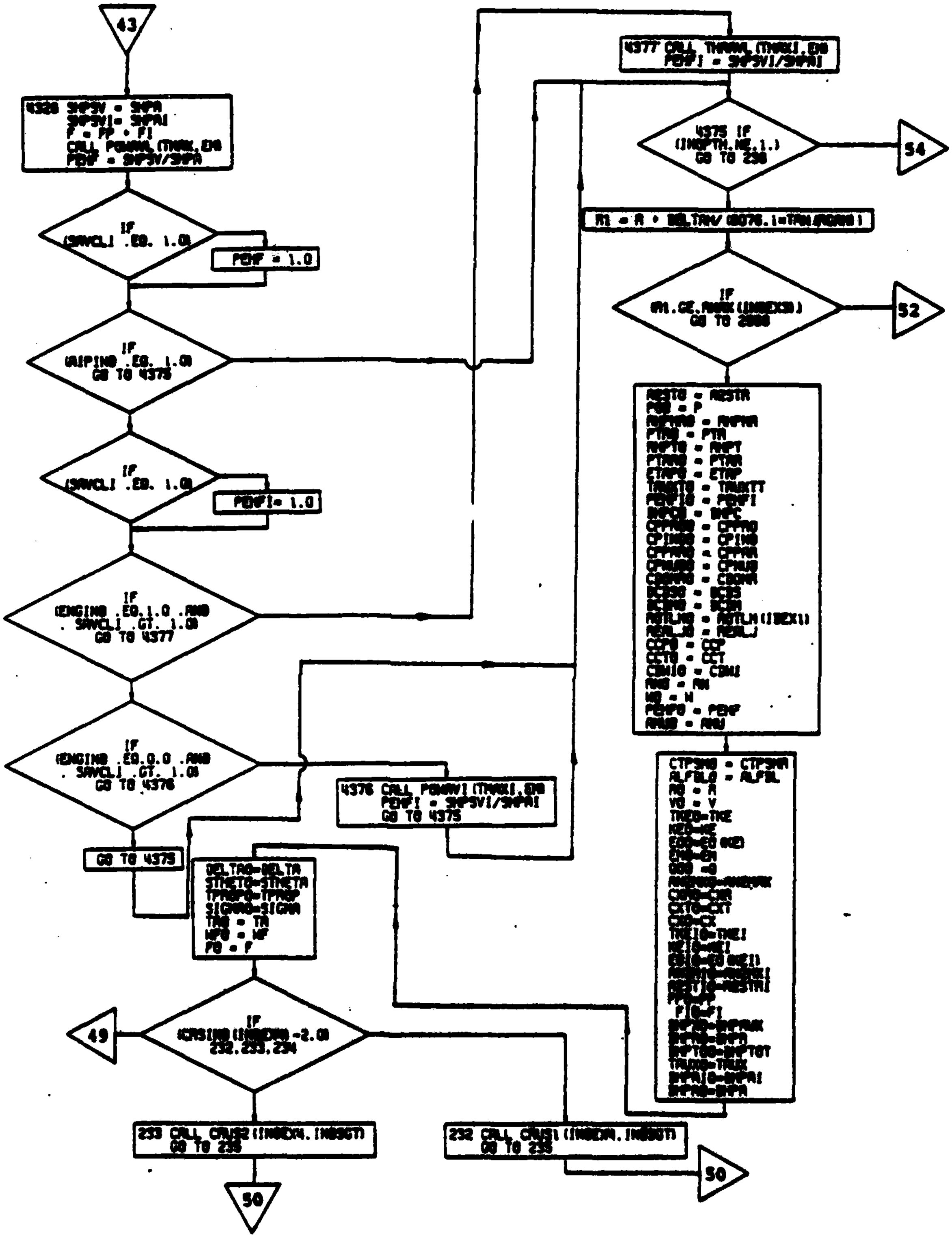


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 12 of 15)

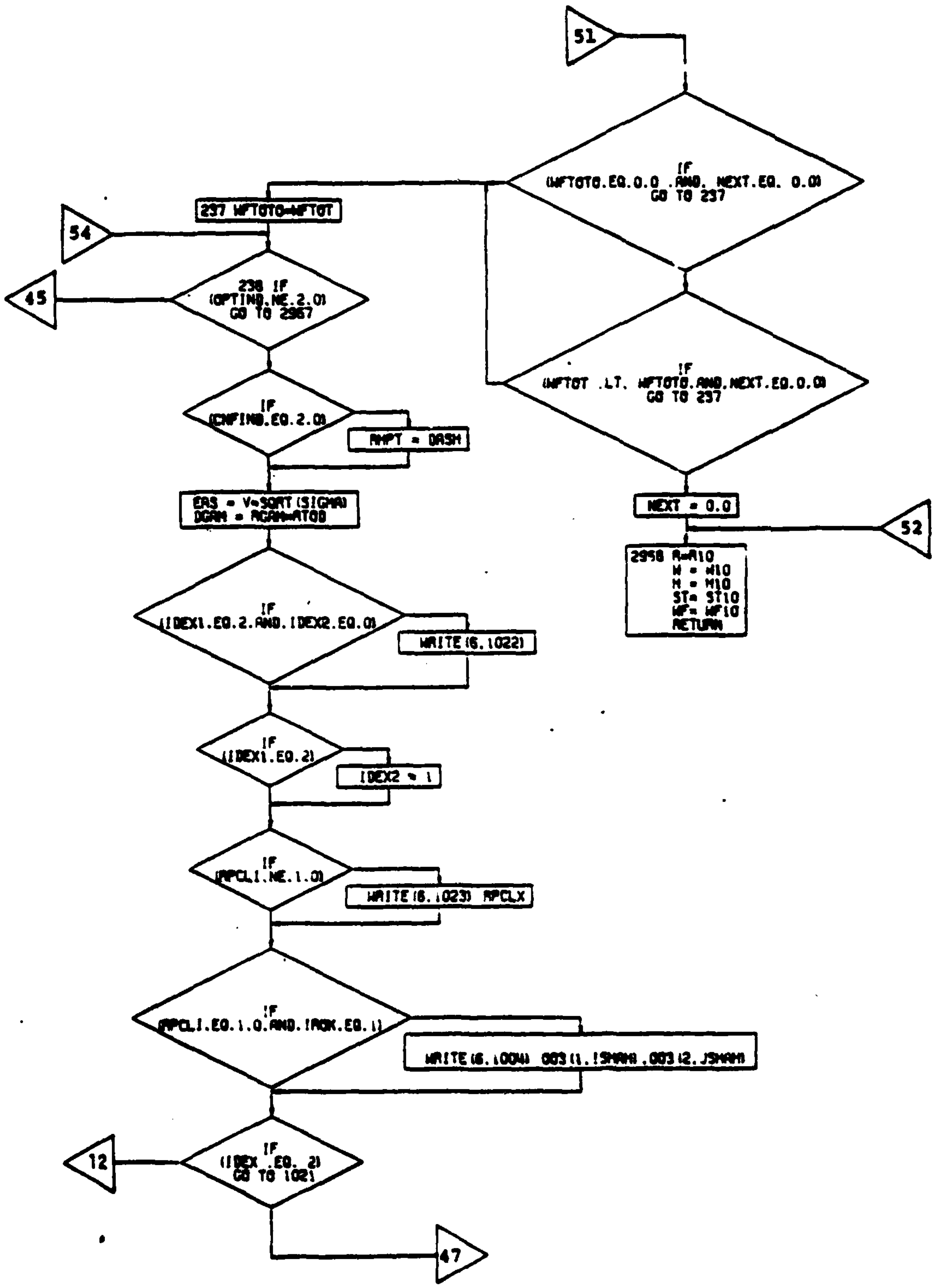


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 13 of 15)

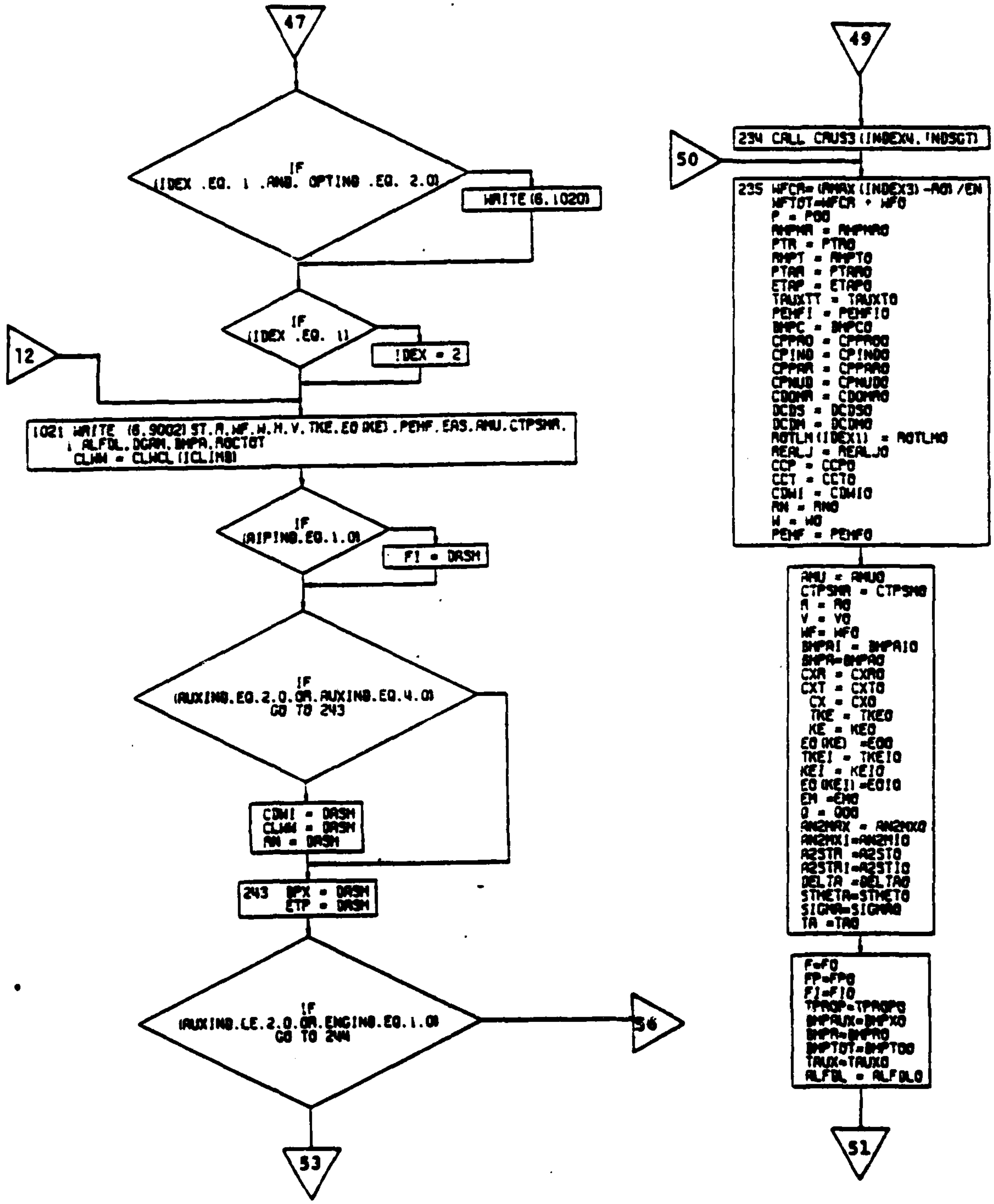


Figure 4-51.. CLIMB Subroutine, Flow Chart (Part 14 of 15)

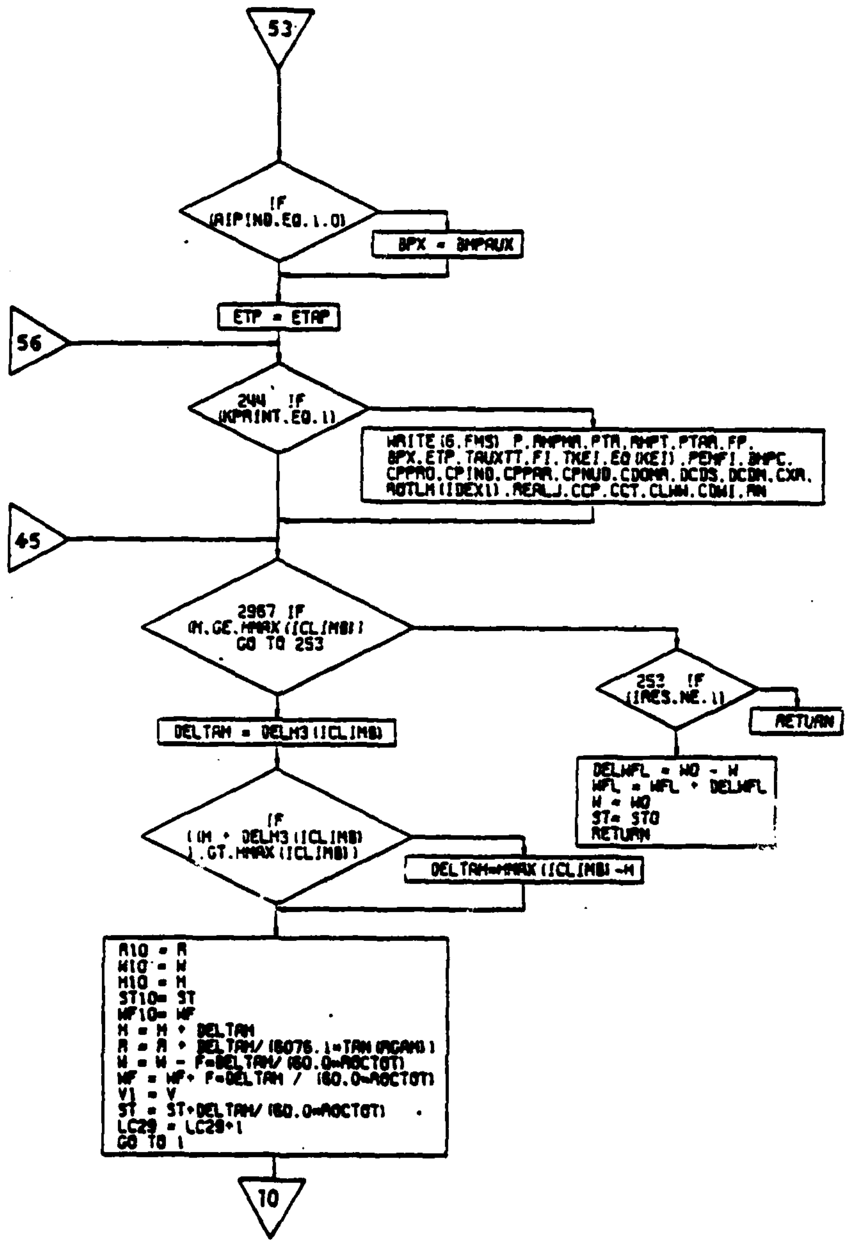


Figure 4-51. CLIMB Subroutine, Flow Chart (Part 15 of 15)

4.12.4 Cruise Calculations Subroutine

The fourth performance segment is the calculation of cruise performance. The cruise performance calculation contains six separate options specifying the type of cruise for the aircraft. This option is determined by an input idnicator, CRSIND.

CRSIND = 1 - This is a calculation of helicopter cruise performance at a fixed cruise power setting and at a constant altitude, constrained by limiting airspeed and Mach number. This option calculates the true airspeed, helicopter advance ratio, specific range, and reduction in gross weight during cruise. In the case of compound and auxiliary propulsion helicopters, if the auxiliary propulsion power required (to satisfy the input T_{AUX}/T_{TOT}) is greater than that available, as determined by POWIND, T_{AUX}/T_{TOT} is readjusted to match the power requirements. It should be further noted that in the case of a configuration having auxiliary independent engines POWIND, which specifies the desired power setting for the primary engines, is used as a limiting factor for the auxiliaries.

CRSIND = 2 - This option will calculate the cruise performance constrained by cruise power and by limiting airspeed and Mach number of the aircraft at constant true airspeed and constant altitude. The program will calculate the power setting required, true airspeed, specific range, and corresponding reduction in gross weight of the aircraft during cruise. In the case of an auxiliary independent engine configuration, if either the primary or auxiliary engine power required is greater than that available, T_{AUX}/T_{TOT} is readjusted accordingly. Then, if a power required-power available match is not achieved, cruise speed is reduced.

CRSIND = 3 - This option calculates the airspeed during cruise required for best specific range, constrained by normal power setting and by limiting airspeed and Mach number. Flight is at constant altitude. When auxiliary independent engines are employed, cruise speed is reduced (T_{AUX}/T_{TOT} not being readjusted from its input value) until both auxiliary and primary power required are less than available.

CRSIND = 4 - This option will calculate the "long range cruise" condition; that is, cruise at speed for

99% of best specific range. Flight is constrained by normal power setting, limiting airspeed and Mach number and is at constant altitude.

CRSIND = 5 - This option is a calculation for a cruise-climb at a constant value of W/δ (airplane weight to ambient pressure ratio). The airspeed will be the speed for best specific range.

CRSIND = 6 - This is a calculation for a cruise climb (constant W/δ) at the speed for 99% of best specific range.

Cruise power setting as discussed above is defined by user input to be maximum (POWIND = 0), military (POWIND = 1), or normal (POWIND = 2) engine rating. This subroutine permits simulation of cruise performance of an aircraft with an arbitrary number of engines (both primary and auxiliary) shut down.

The program user specifies the number of engines shut down and a corresponding increment in airplane equivalent flat plate area drag.

The user may also specify a desired value of headwind when CRSIND = 3 through 6.

It is possible to use a cruise segment in the mission profile to account for a reserve fuel requirement (SGTIND = 40) (in such a case the helicopter weight at the end of cruise is set back to the weight at the beginning of cruise) or as a part of the basic mission (in this case the weight is not reset). In either case, the fuel used during cruise is included in the total fuel required to size the helicopter.

The input for the subroutine consists of the final range for cruise, the step size (incremental range), number of engines shut down, increment in drag coefficient, atmospheric conditions, required true airspeed (if CRSIND = 2) the headwind (if CRSIND = 3, 4, 5, or 6) and the settings for CRSIND and POWIND. Figure 4-52 is a flow chart of this subroutine.

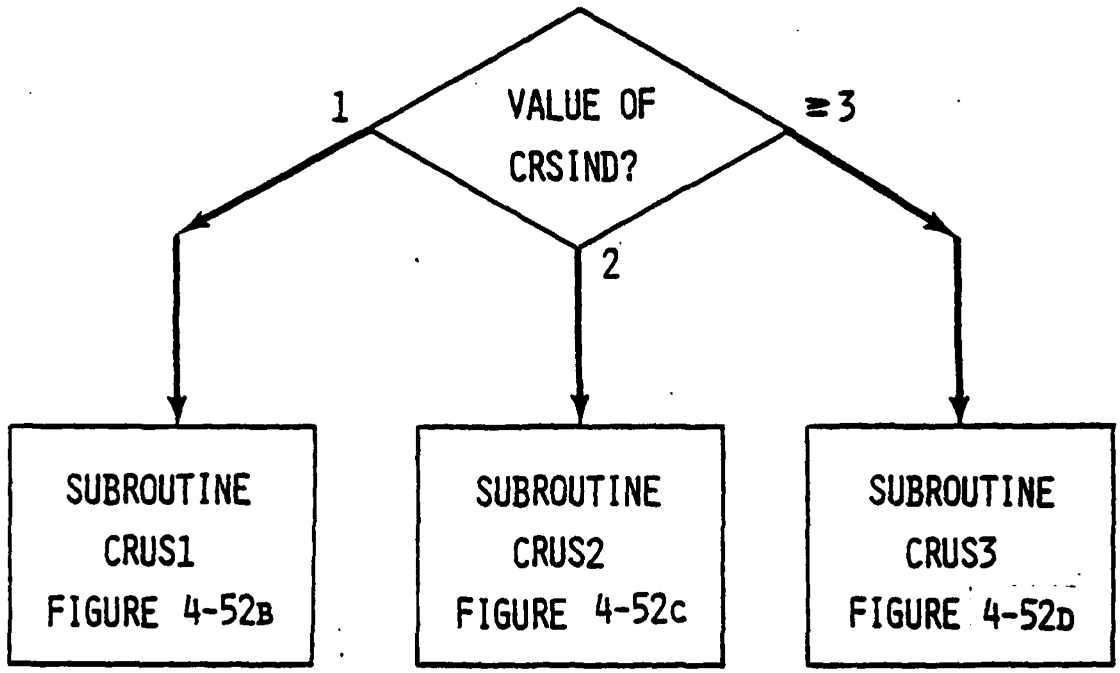


Figure 4-52a. Cruise Calculations Subroutine.

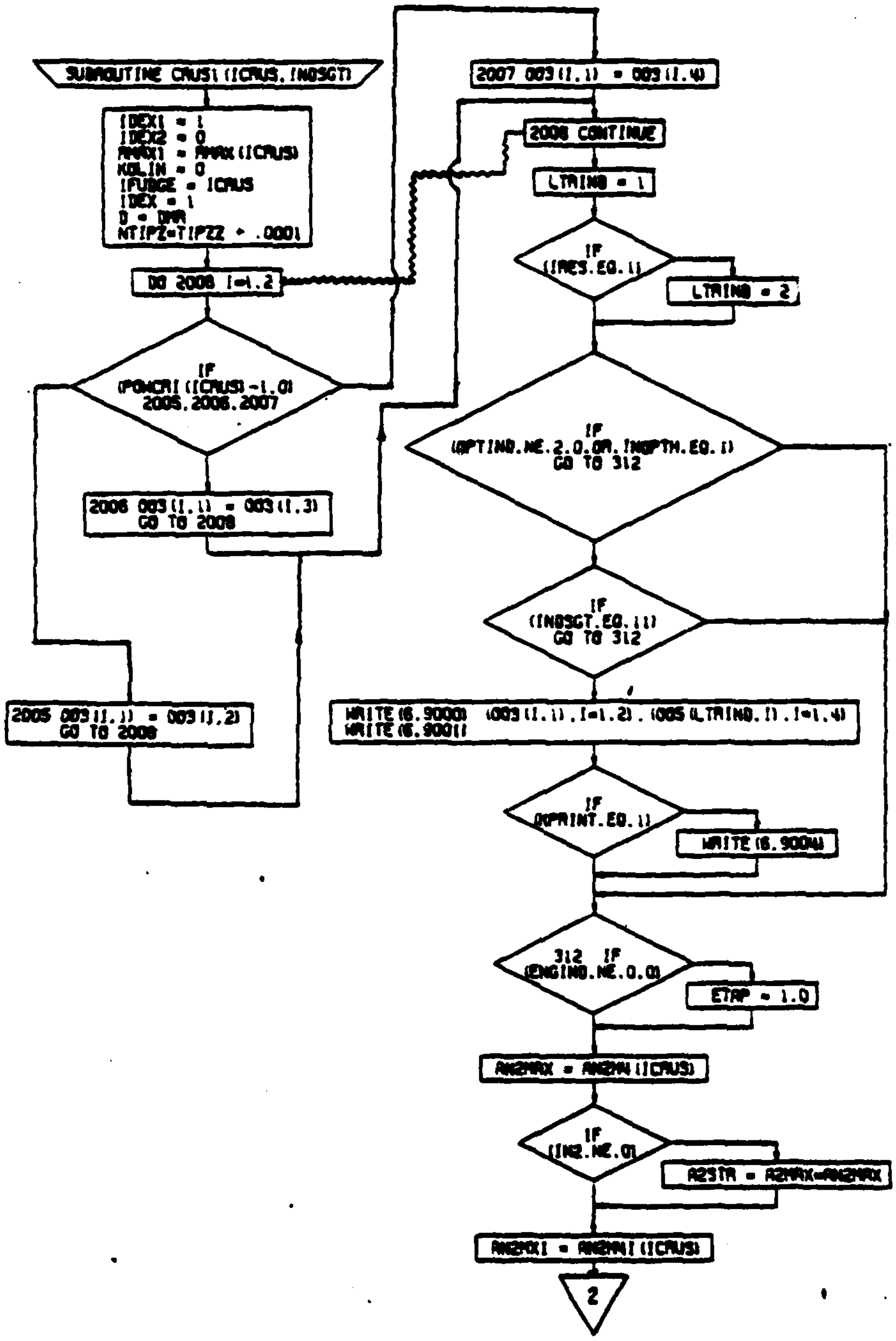


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 1 of 12)

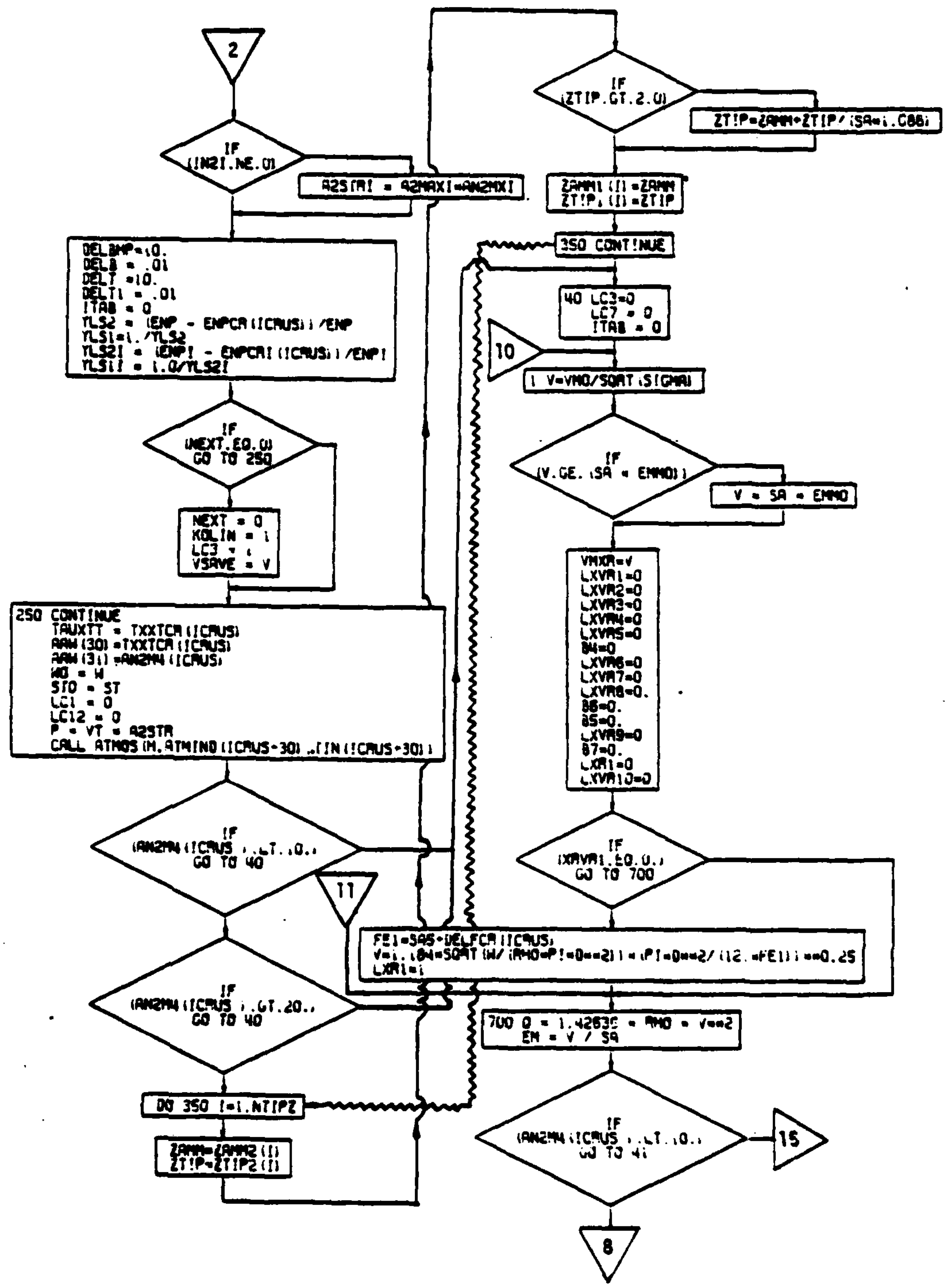


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 2 of 12)

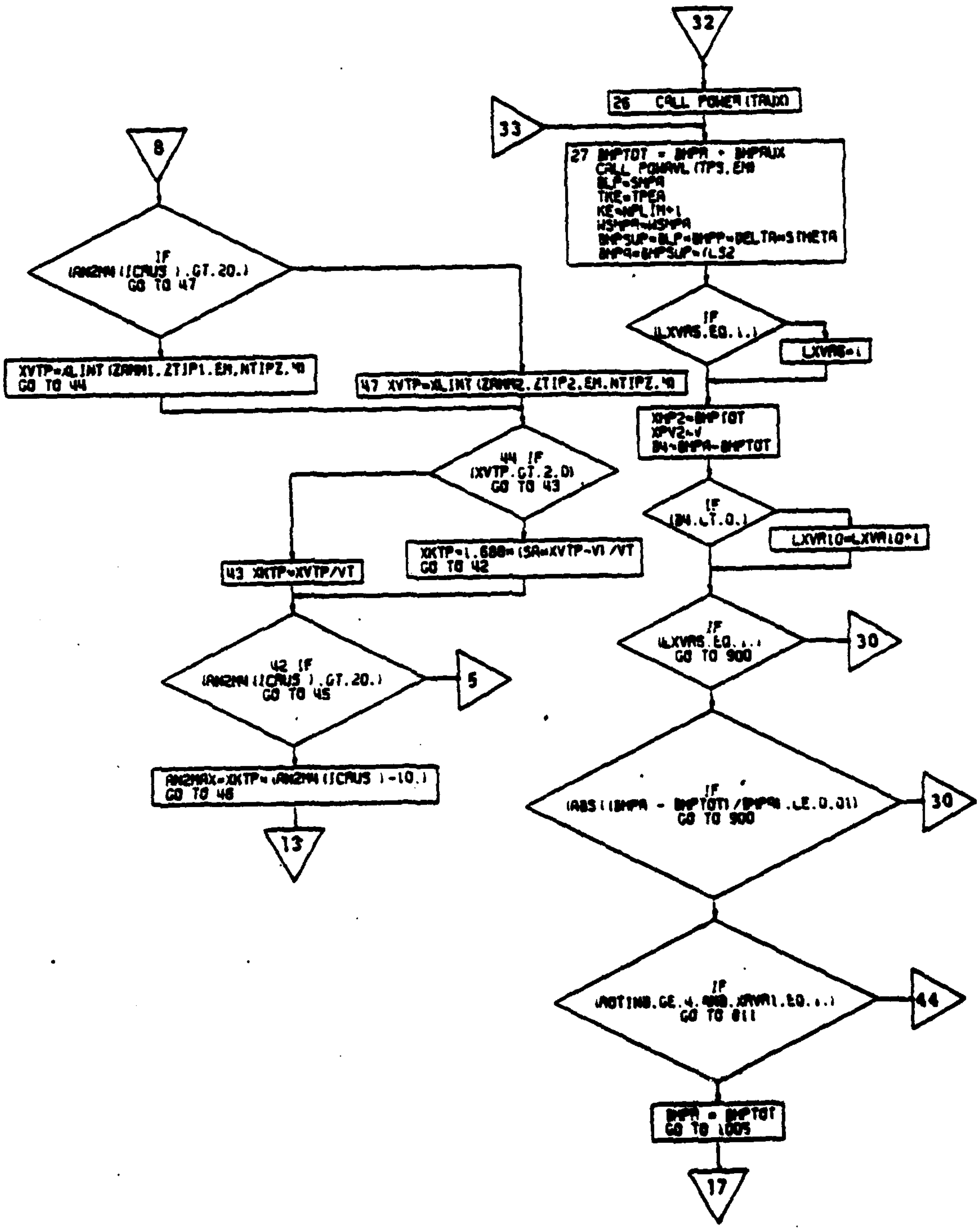


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 3 of 12)

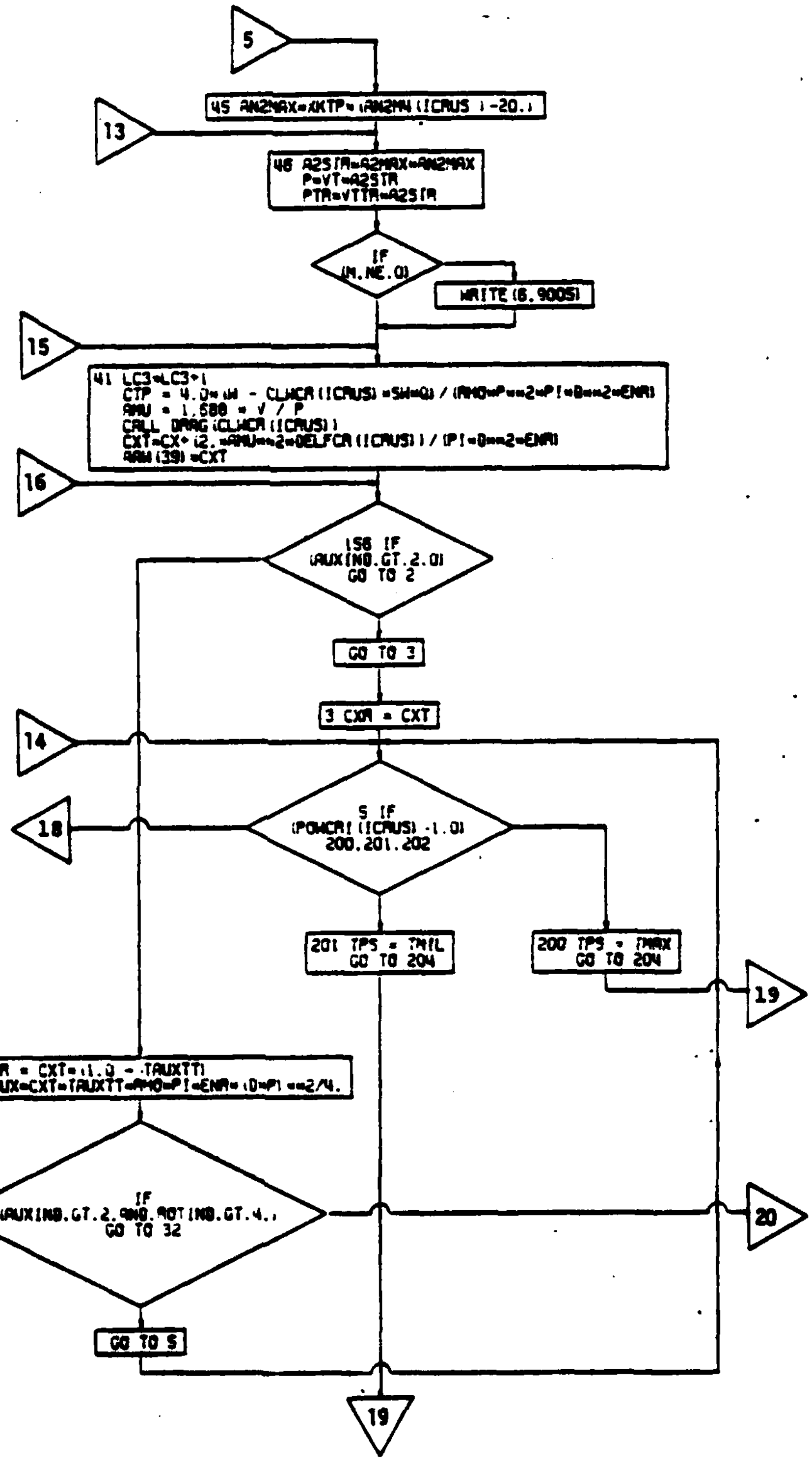


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 4 of 12)

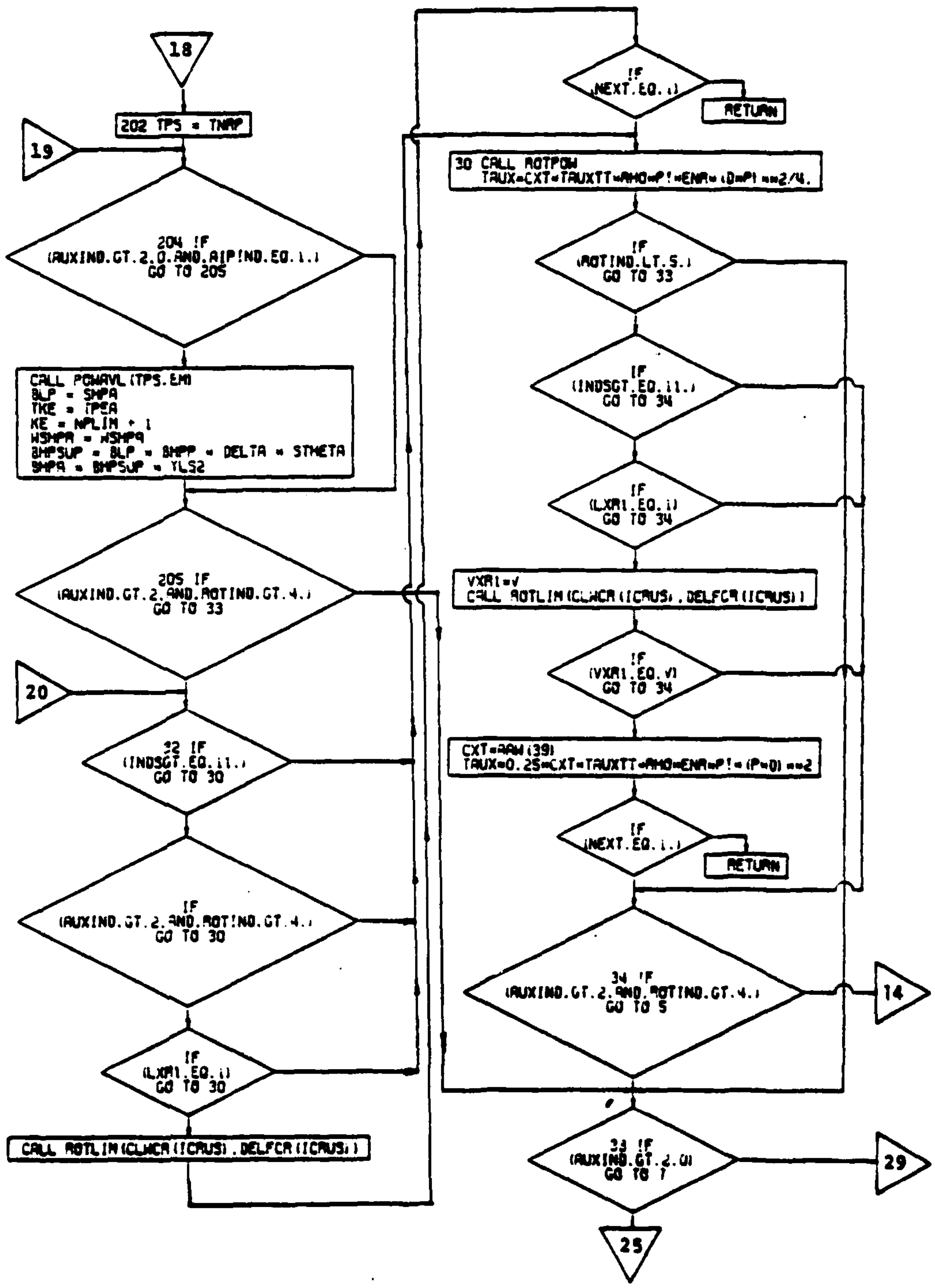


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 5 of 12)

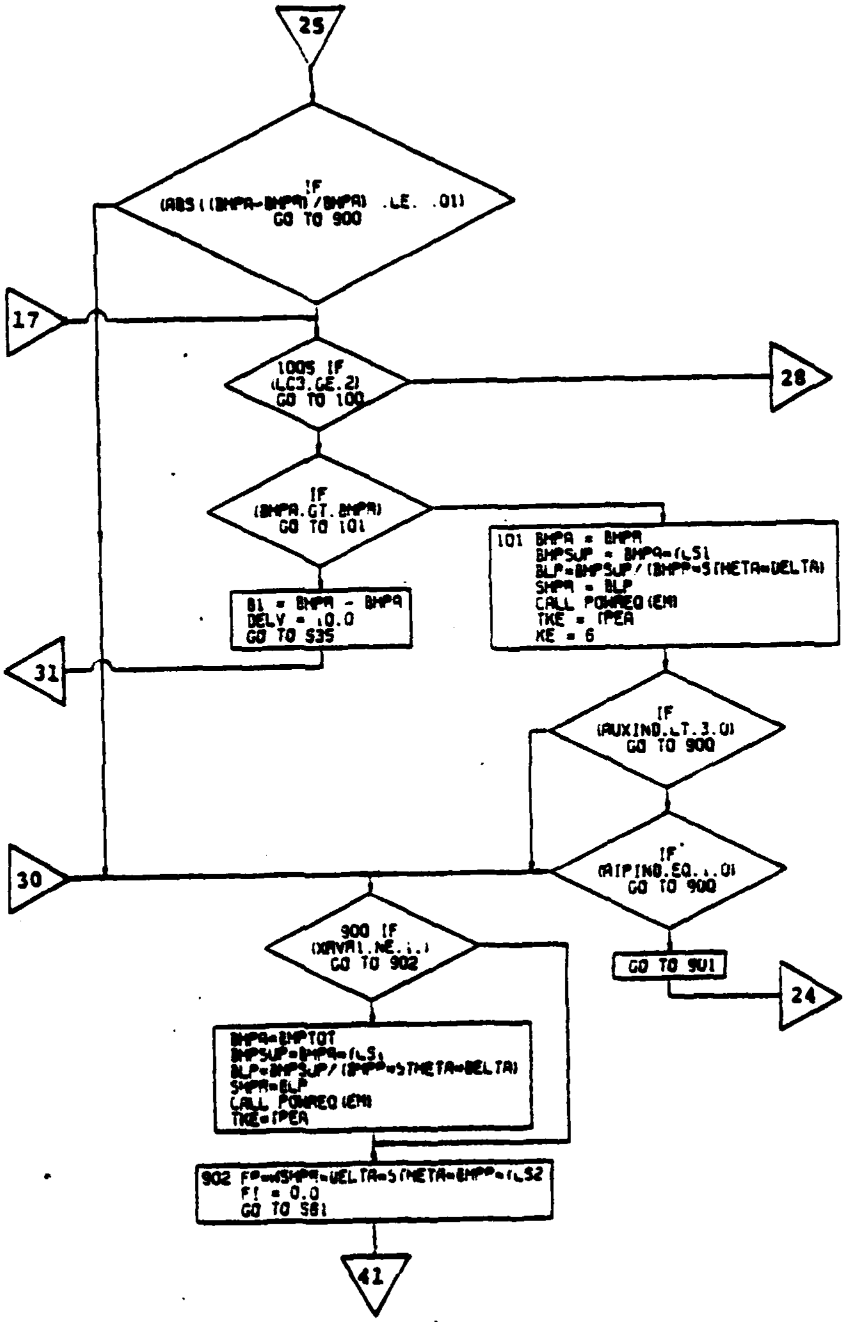


Figure 4-52b. Cruise-1 Subroutine, Flow Chart (Part 6 of 12)

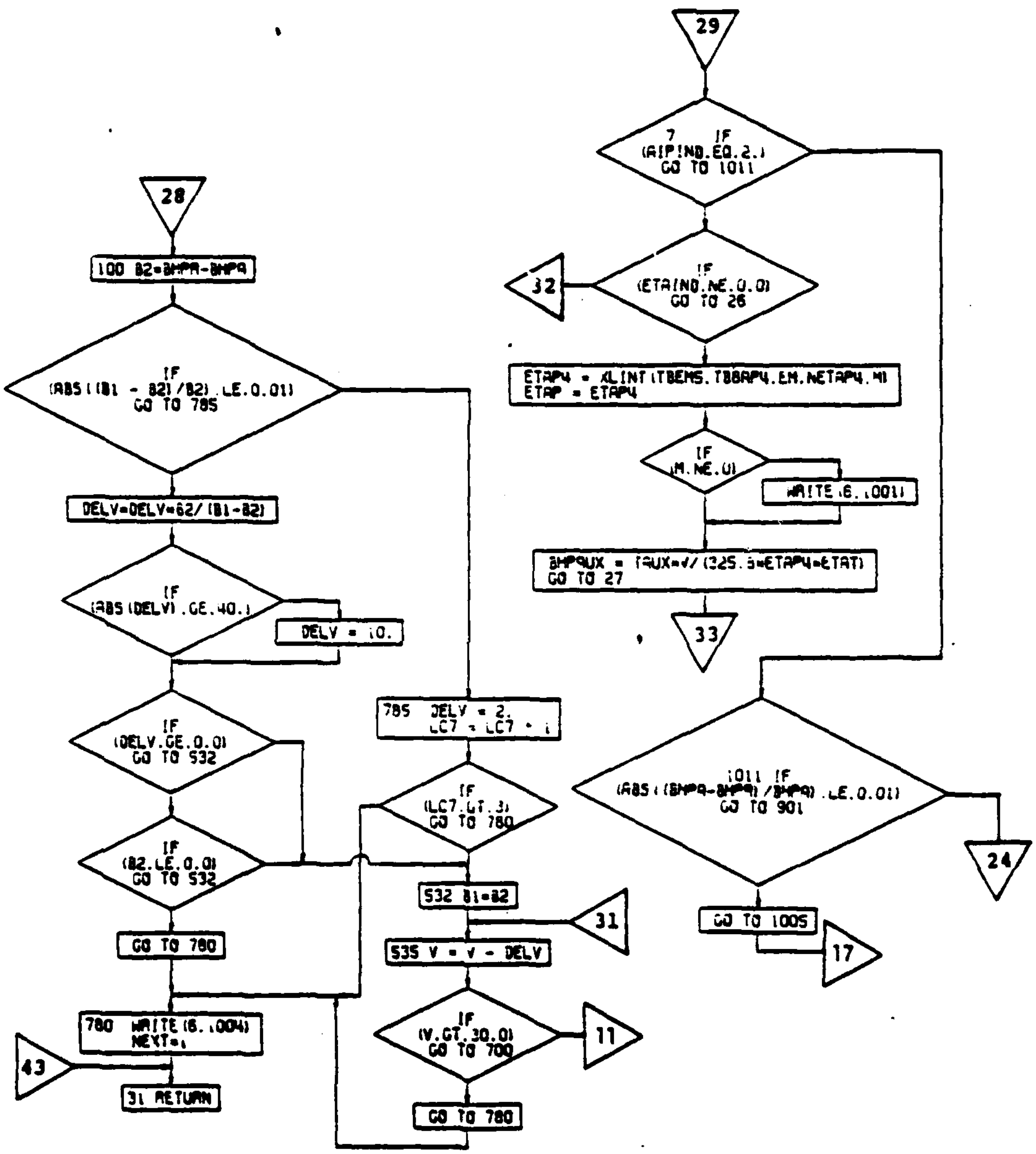


Figure 4-52b. Cruise-1 Subroutine, Flow Chart (Part 7 of 12)

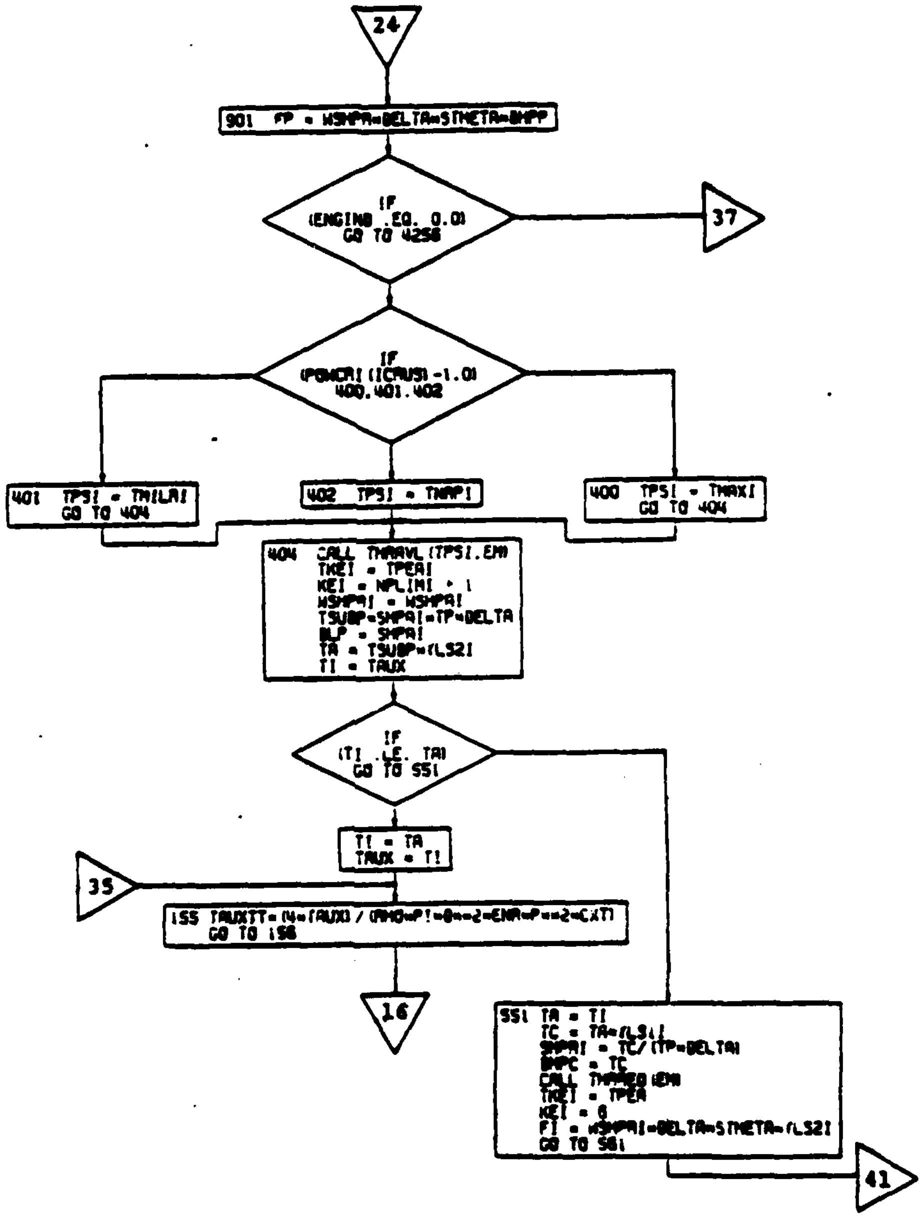


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 8 of 12)

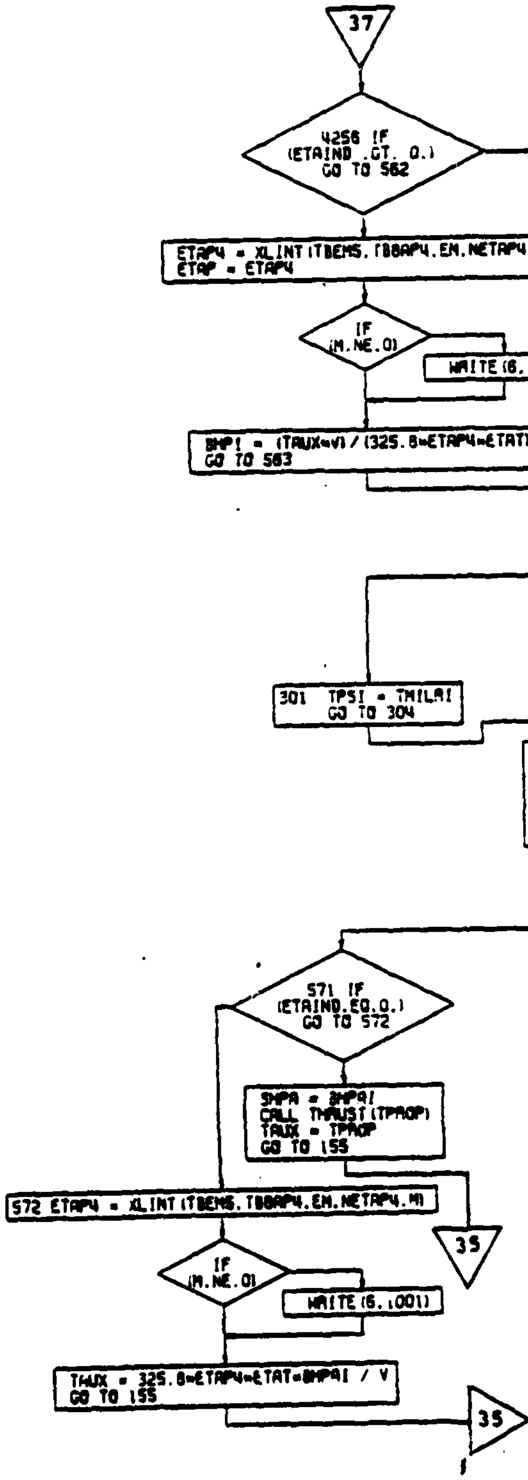


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 9 of 12)

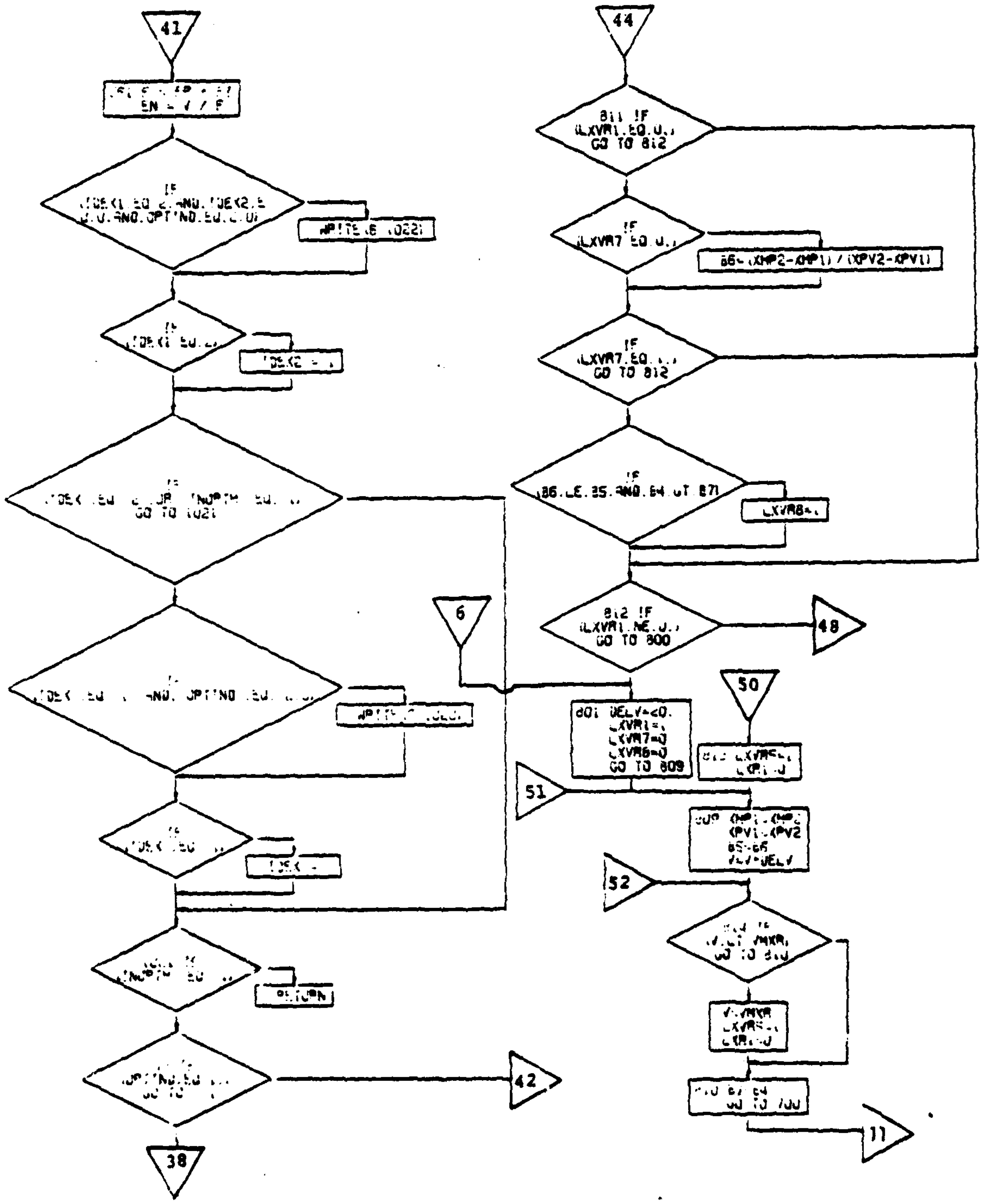


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 10 of 12)

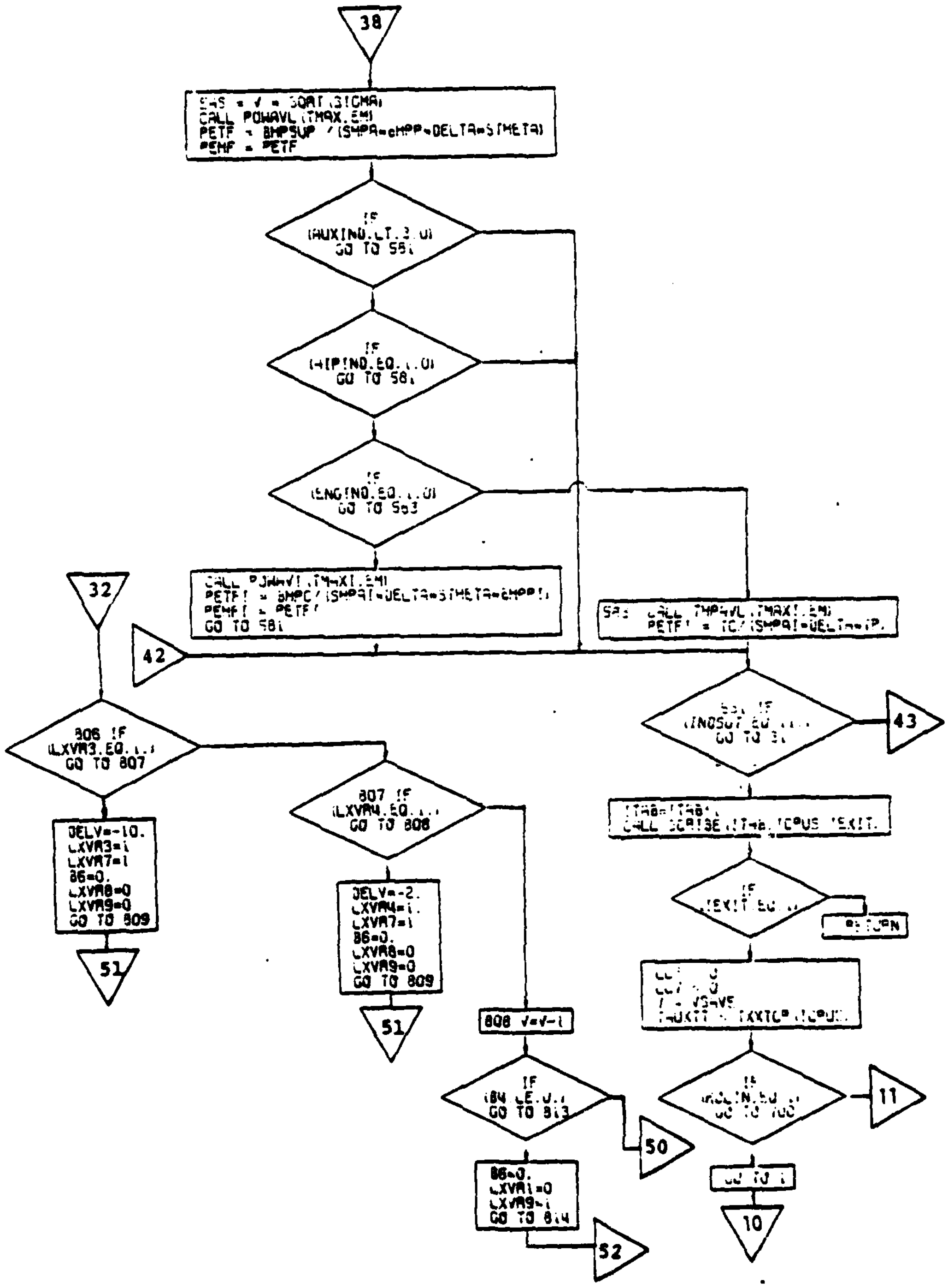


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 11 of 12)

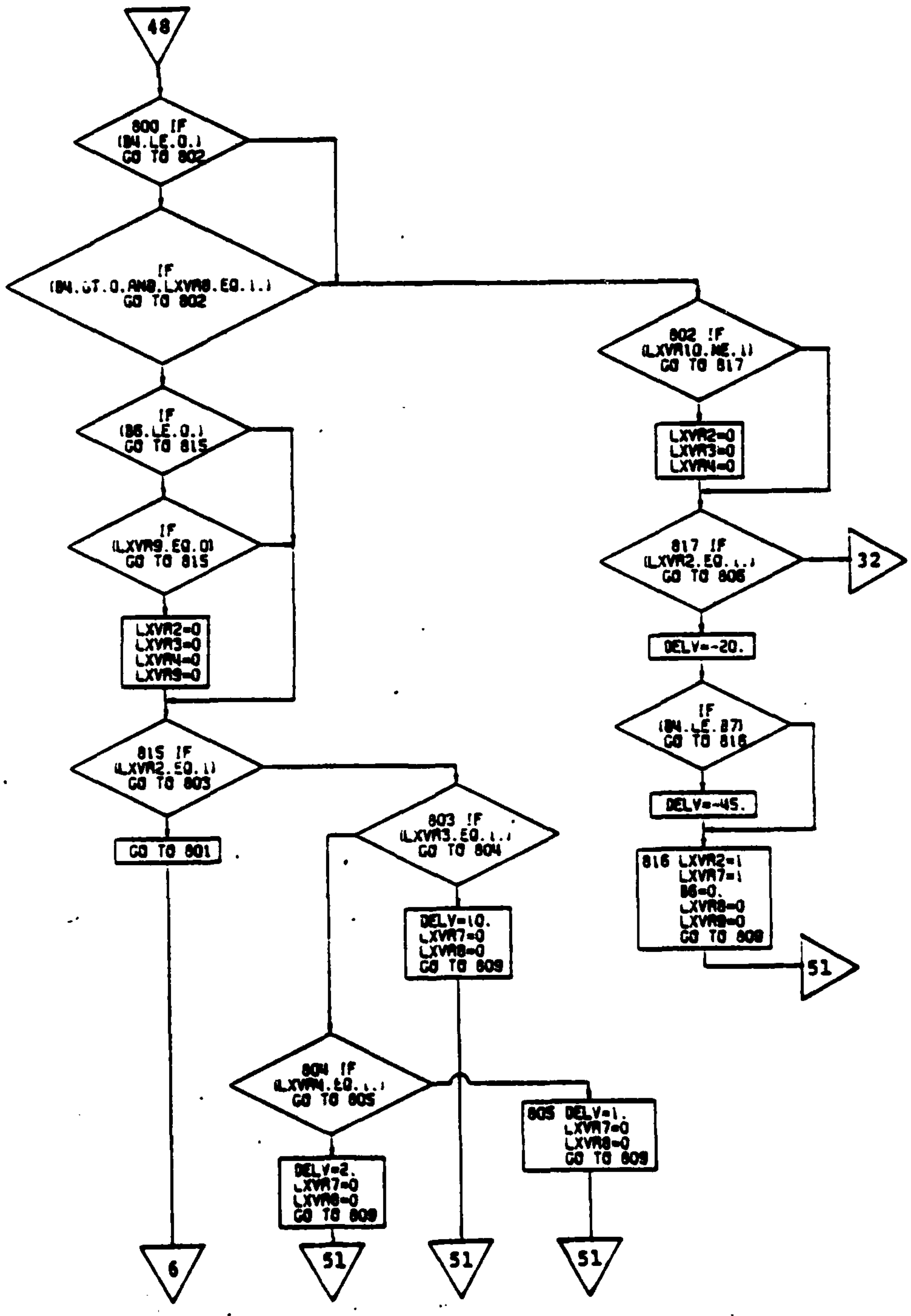


Figure 4-52b. Cruise 1 Subroutine, Flow Chart (Part 12 of 12)

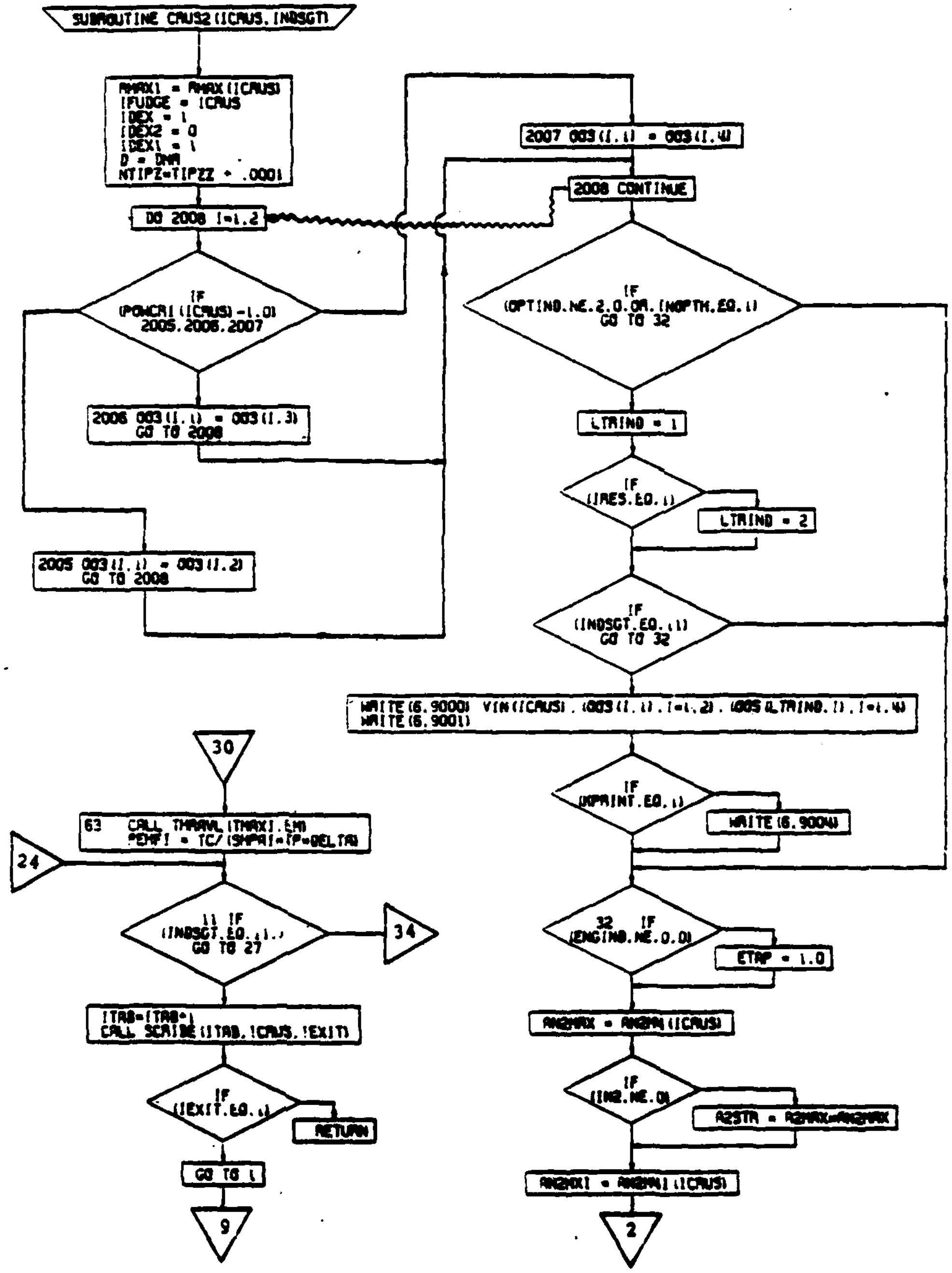


Figure 4-52c. Cruise 2 Subroutine, Flow Chart (Part 1 of 8)

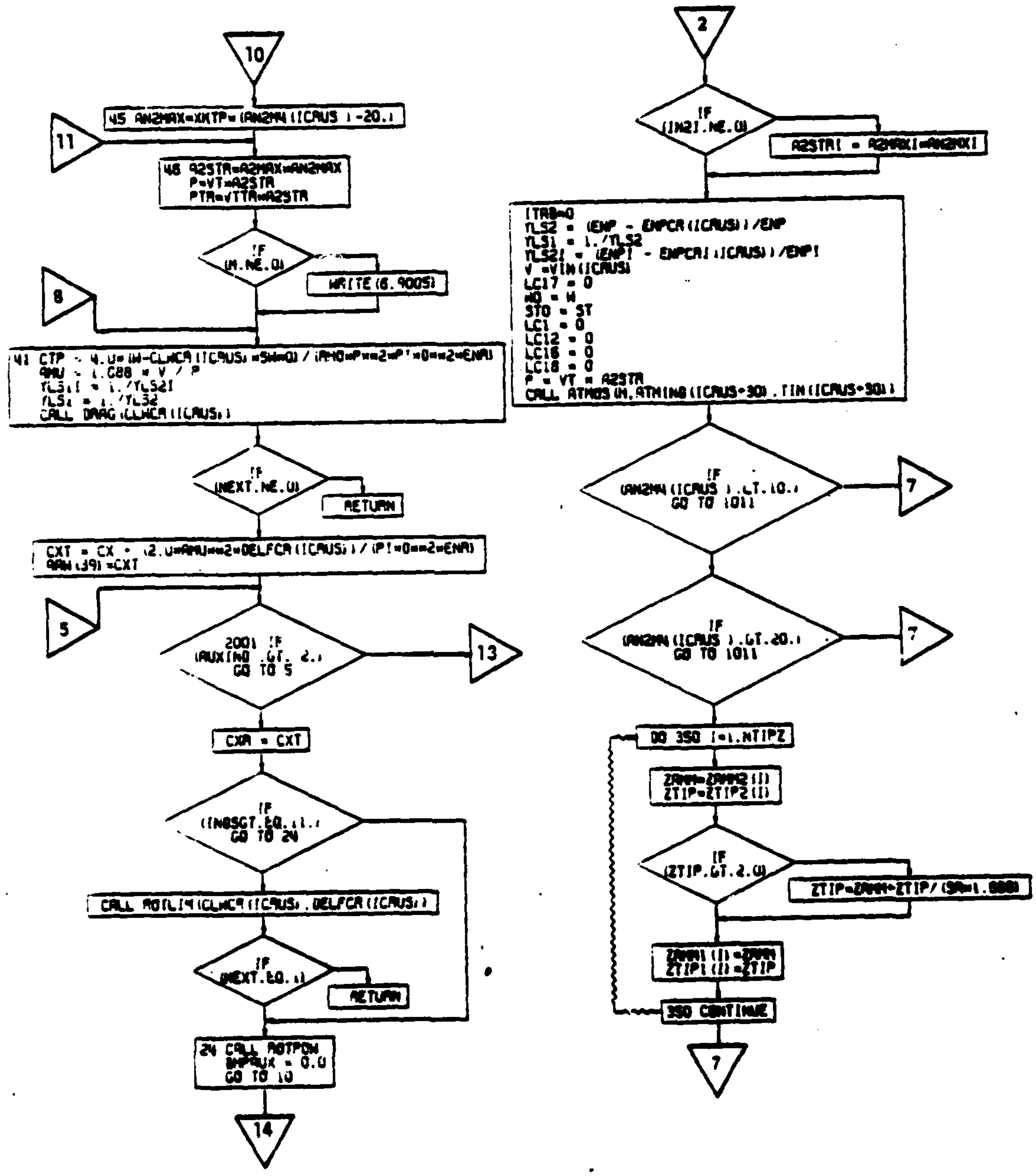


Figure 4-52c. Cruise 2 Subroutine, Flow Chart (Part 2 of 8)

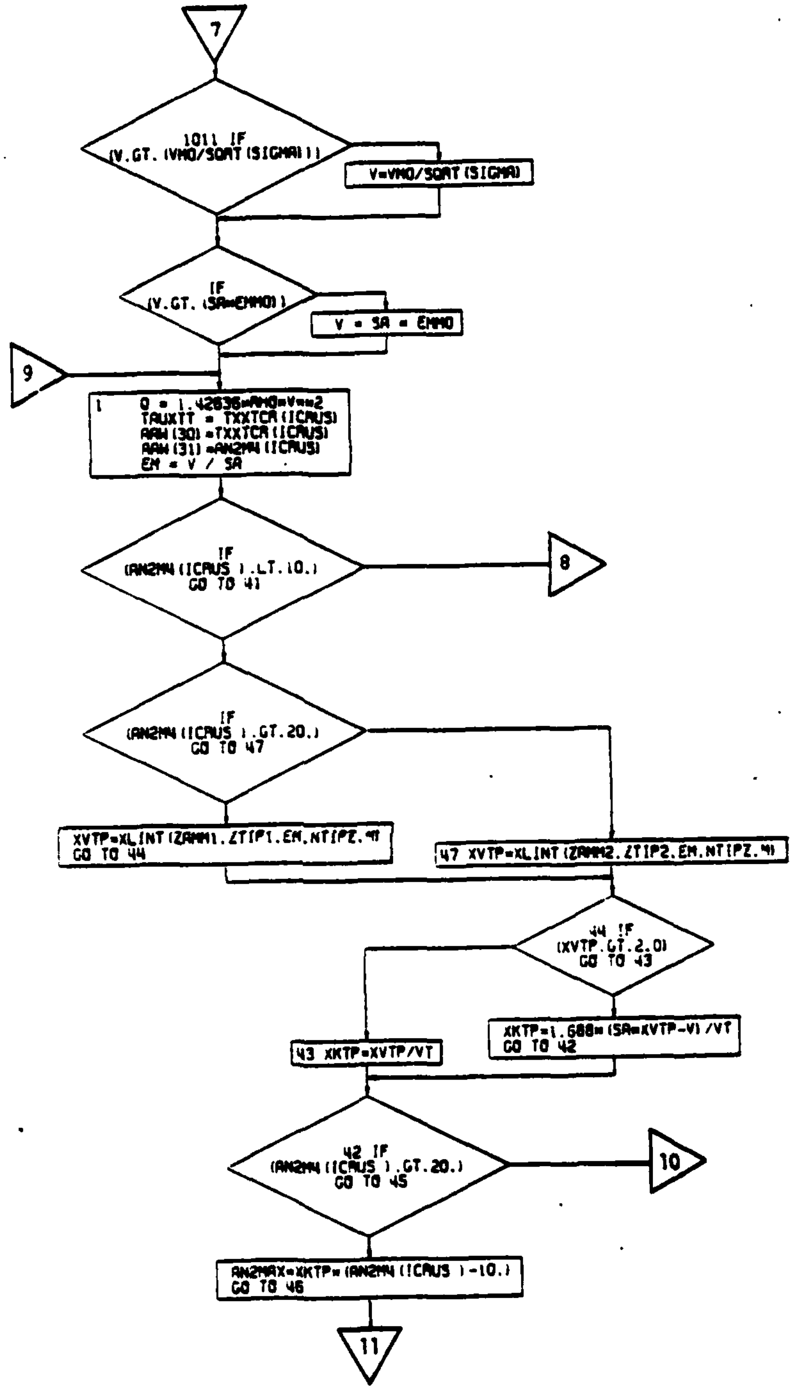


Figure 4-52c. Cruise 2 Subroutine, Flow Chart (Part 3 of 8)

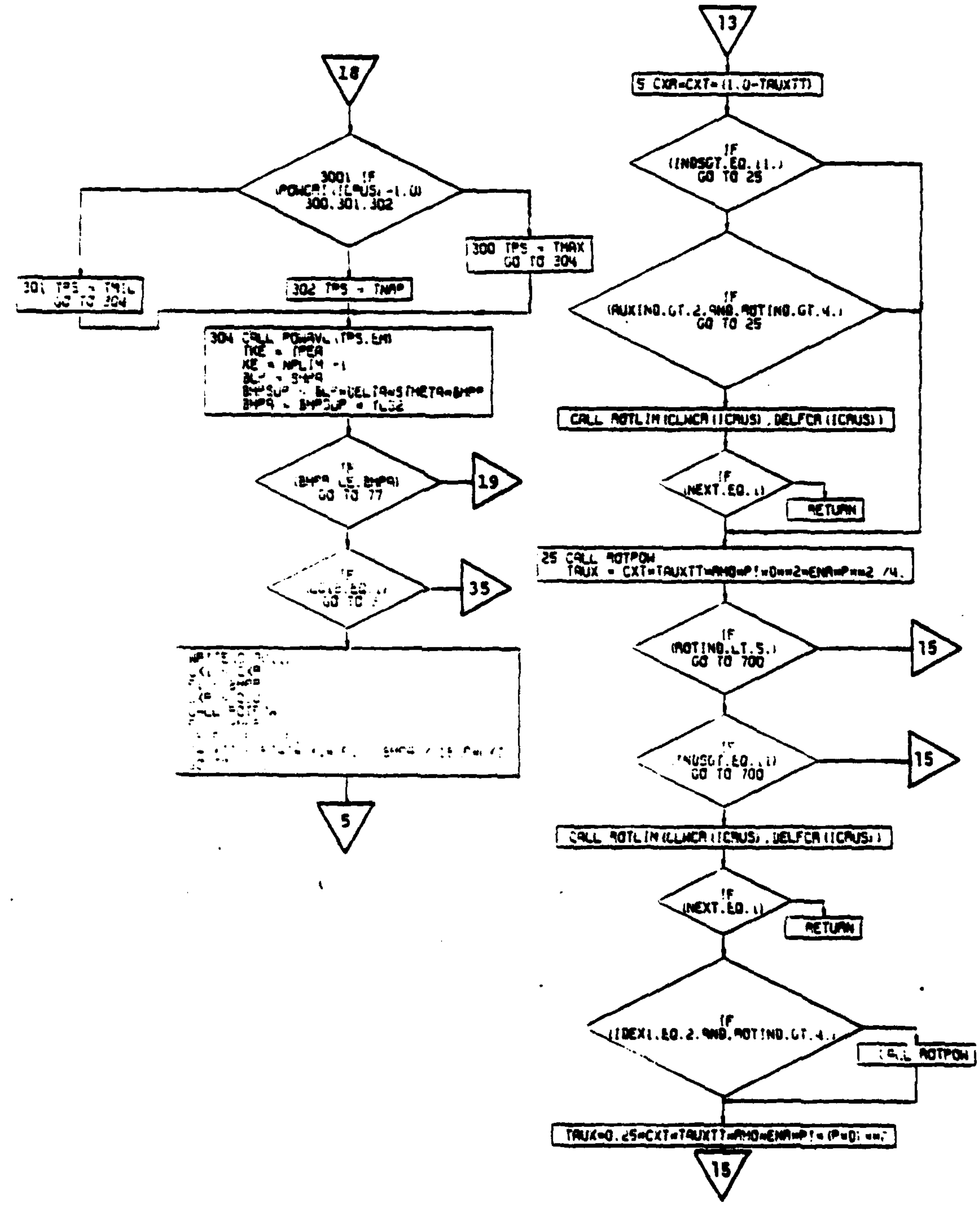


Figure 4-52c. Cruise 2 Subroutine, Flow Chart (Part 4 of 8)

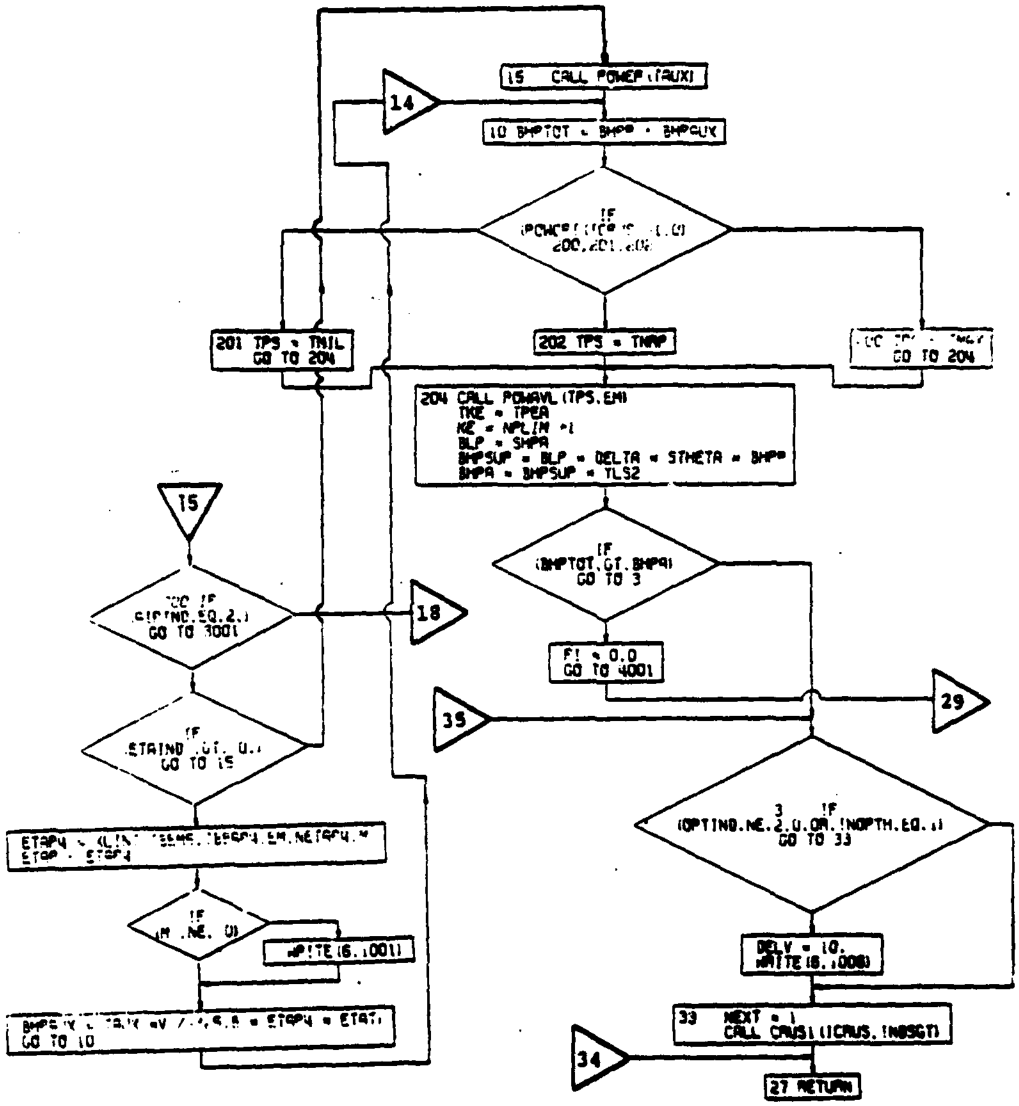


Figure 4-52c. Cruise 2 Subroutine, Flow Chart (Part 5 of 8)

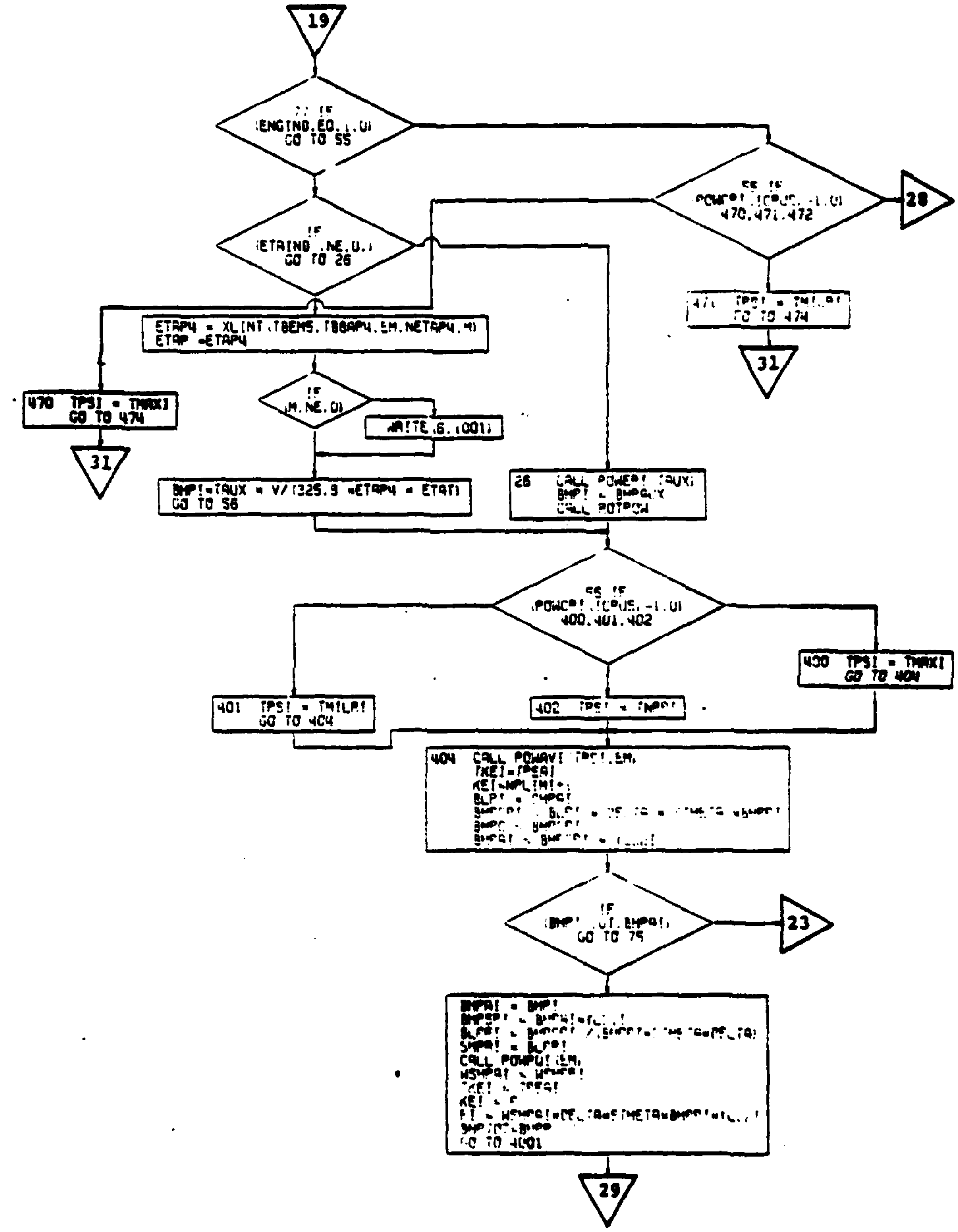


Figure 4-52c. Cruise 2 Subroutine, Flow Chart (Part 6 of 8)

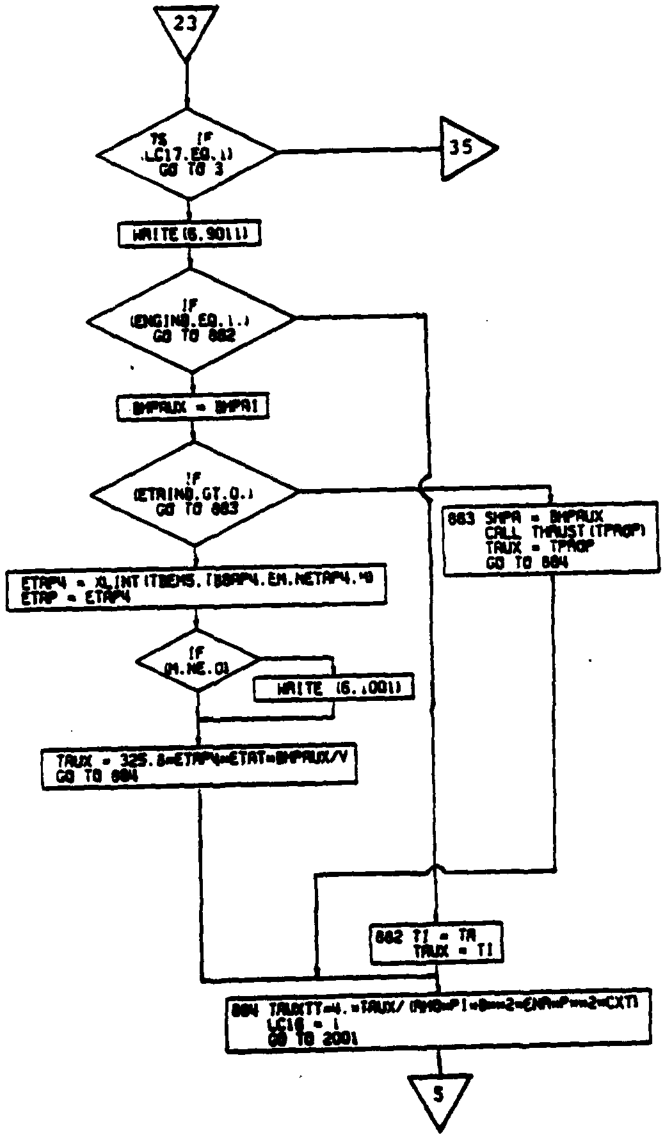


Figure 4-52c. Cruise 2 Subroutine, Flow Chart (Part 7 of 8)

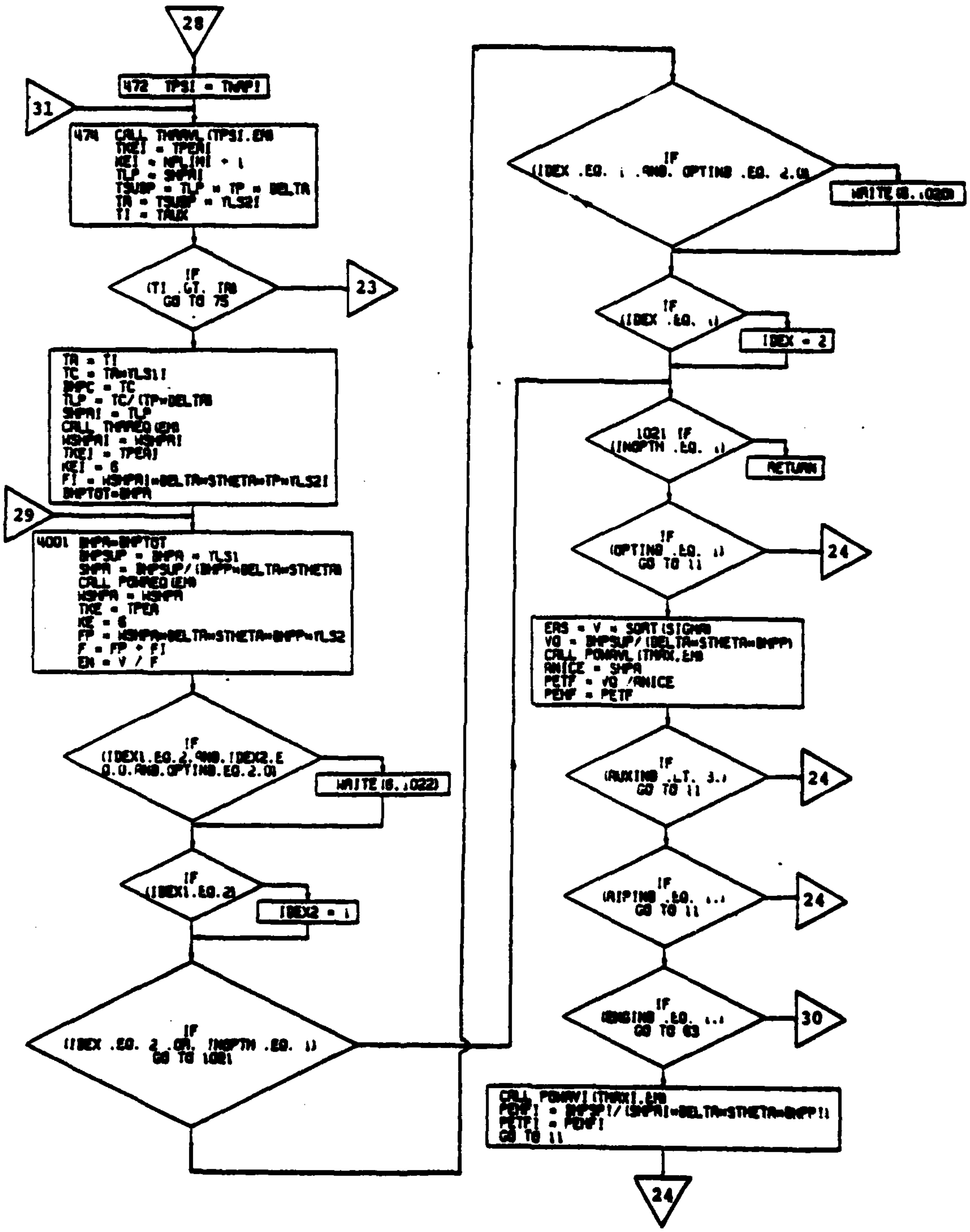


Figure 4-52c. Cruise 2 Subroutine, Flow Chart (Part 8 of 8)

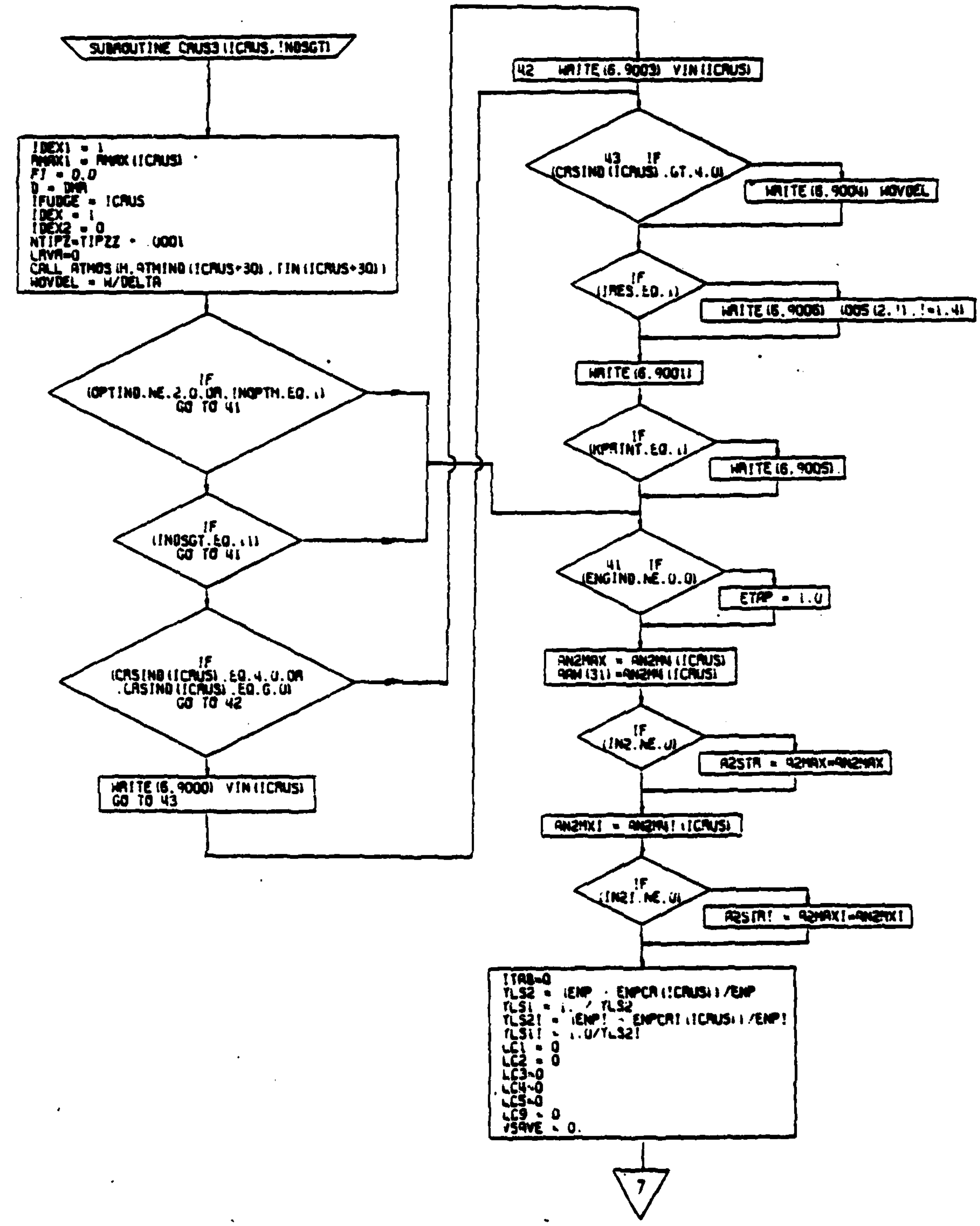


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 1 of 10)

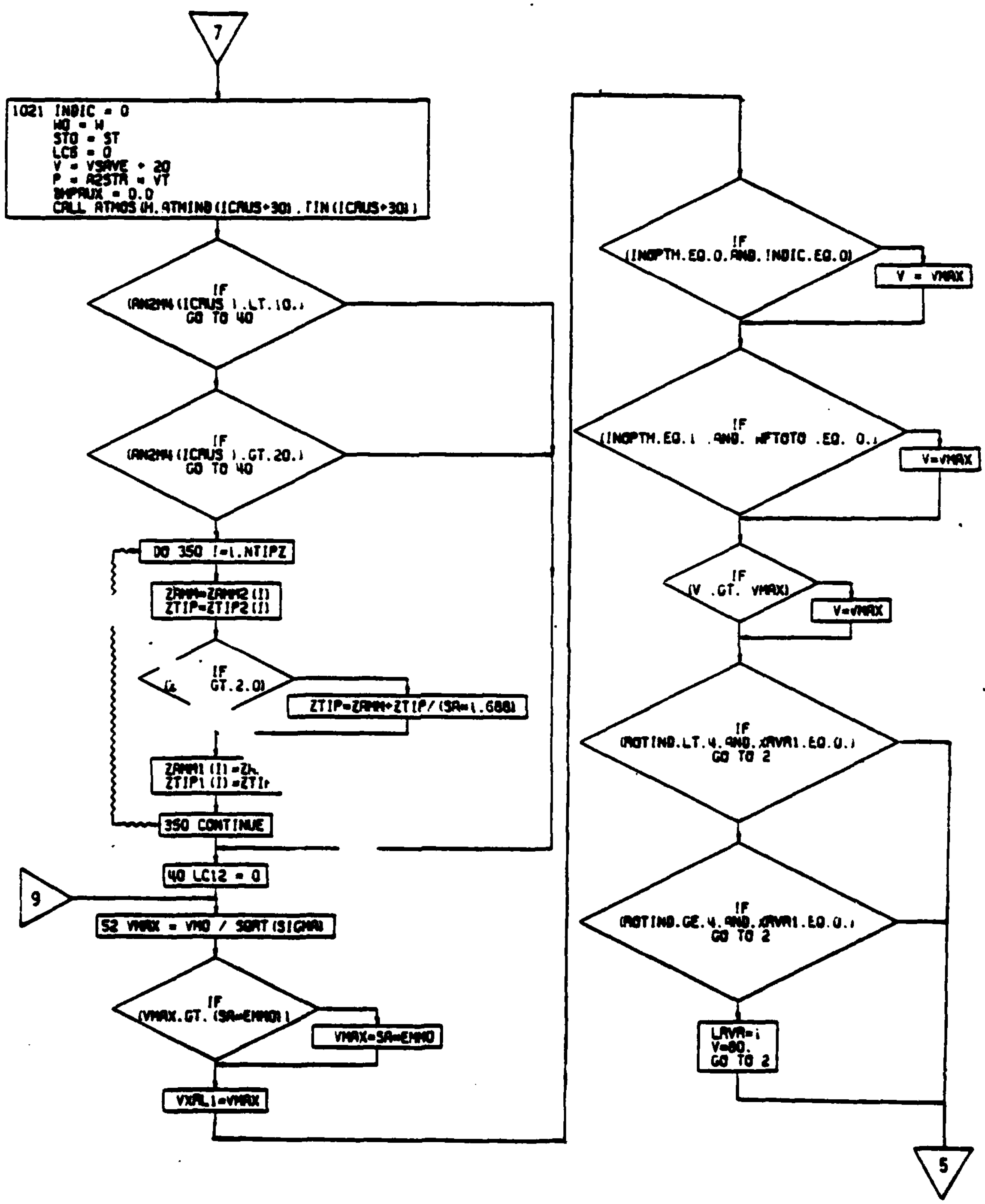


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 2 of 10)

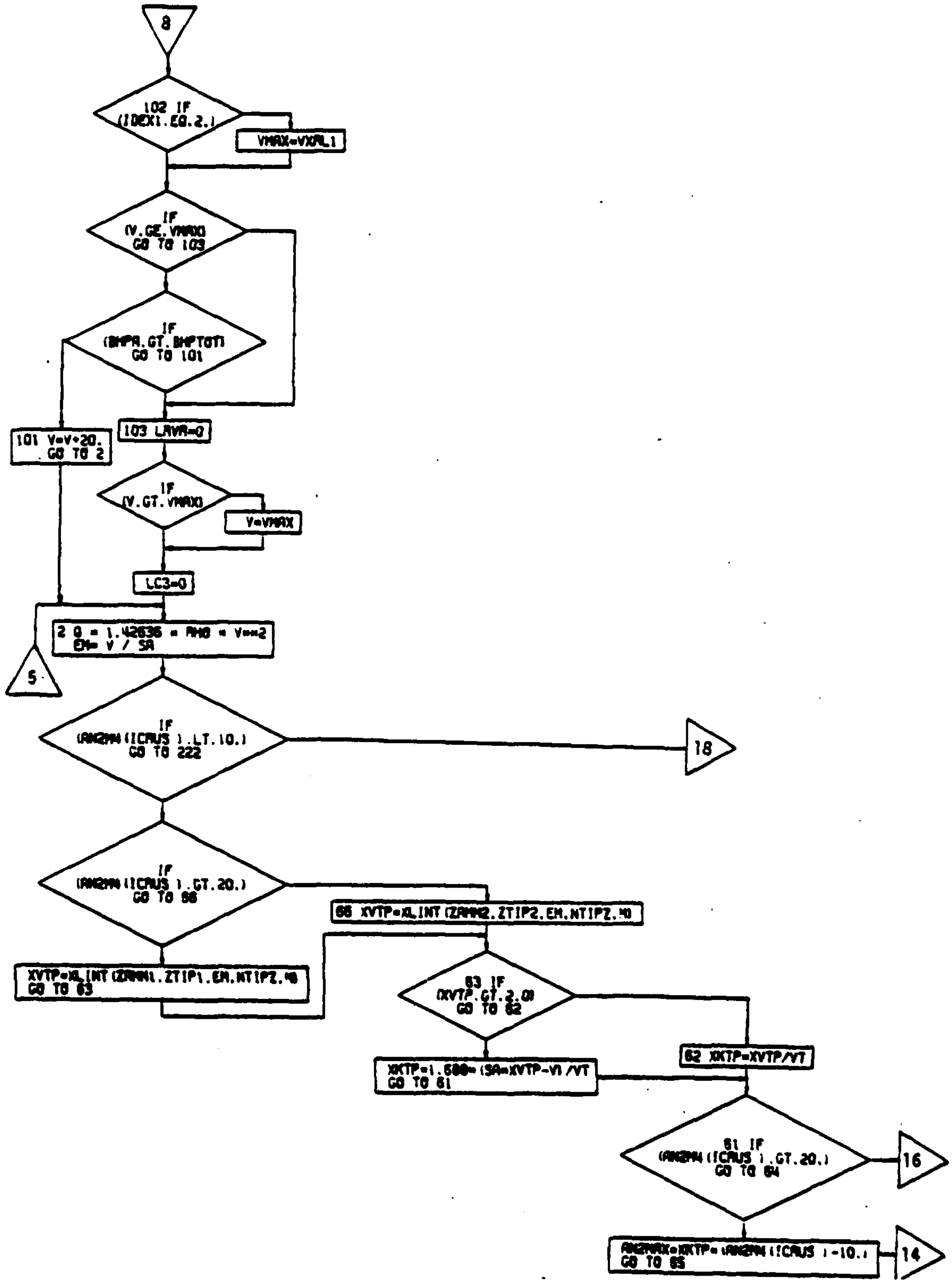


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 3 of 10)

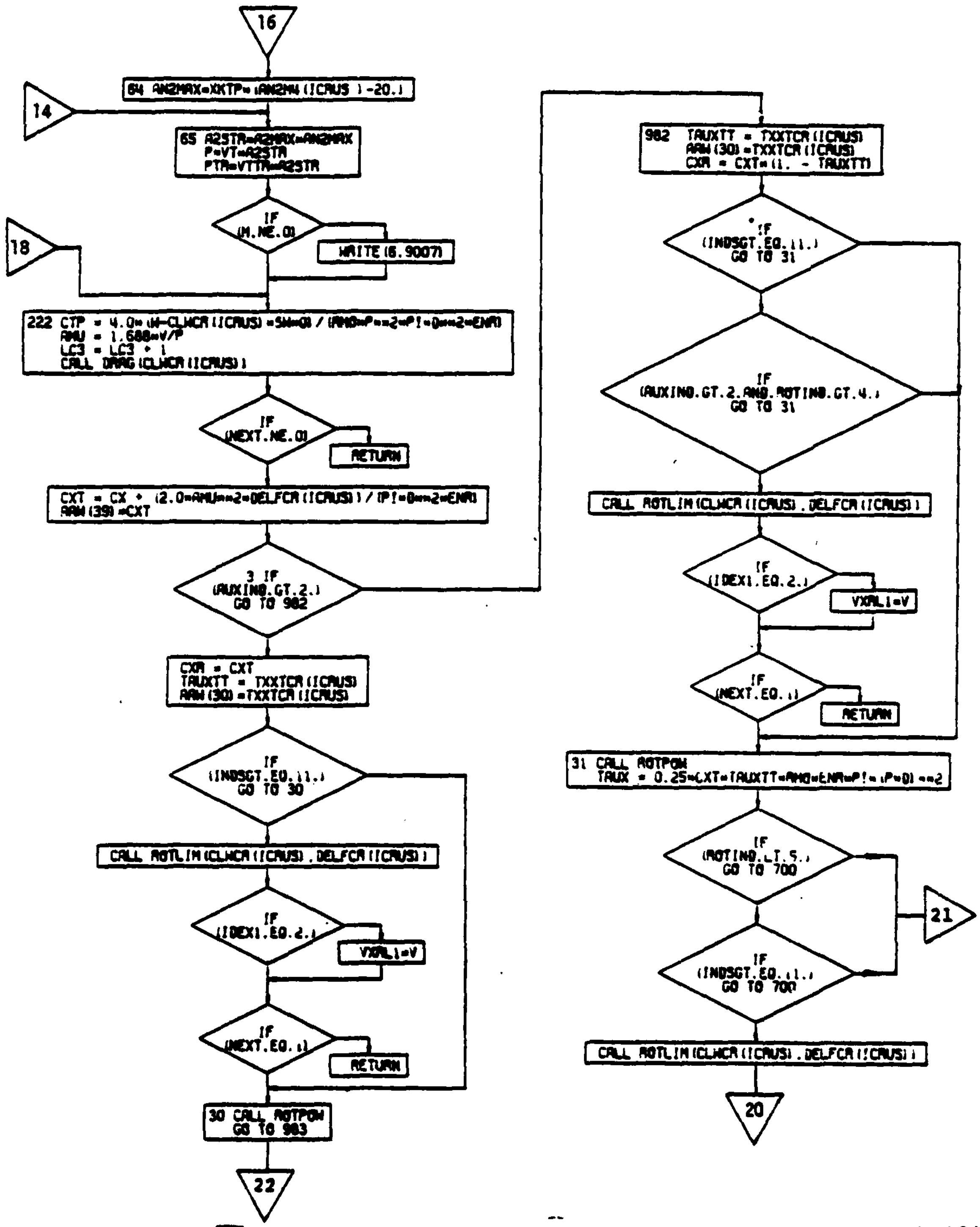


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 4 of 10)

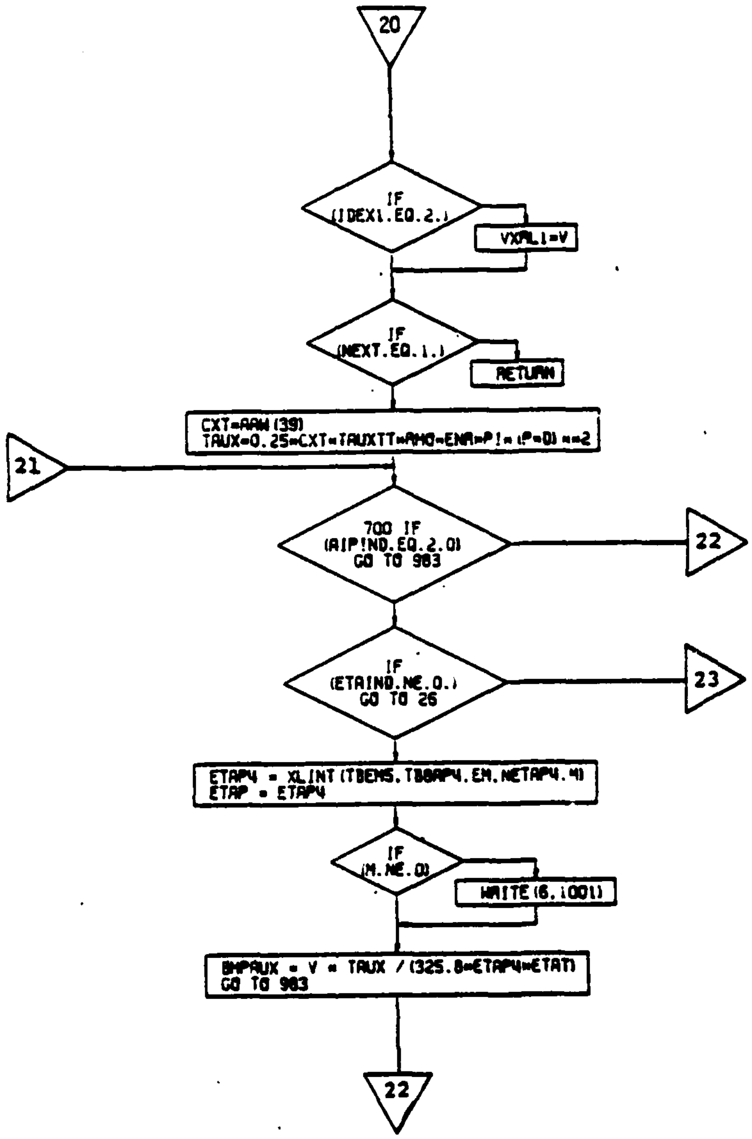


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 5 of 10)

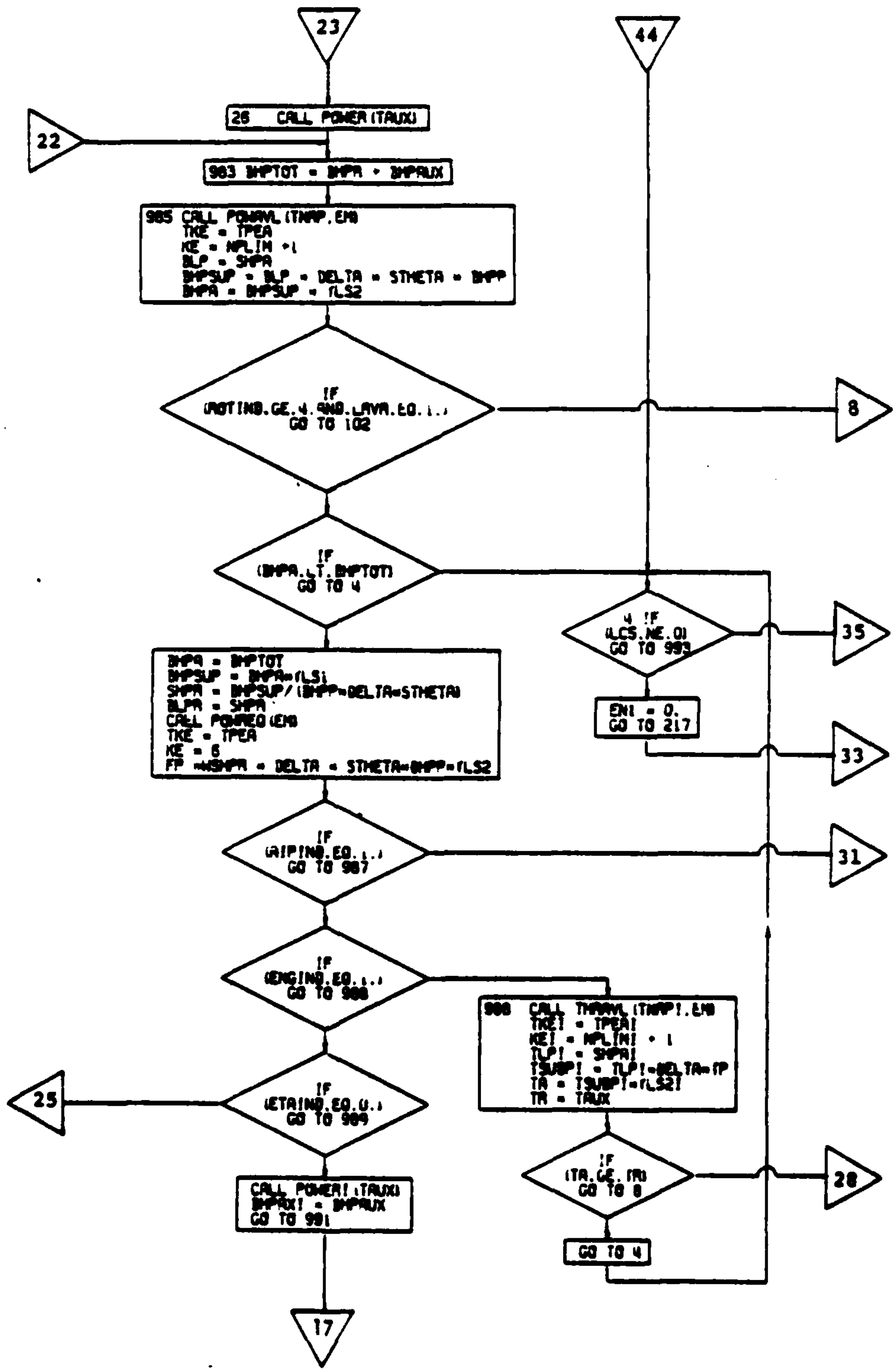


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 6 of 10)

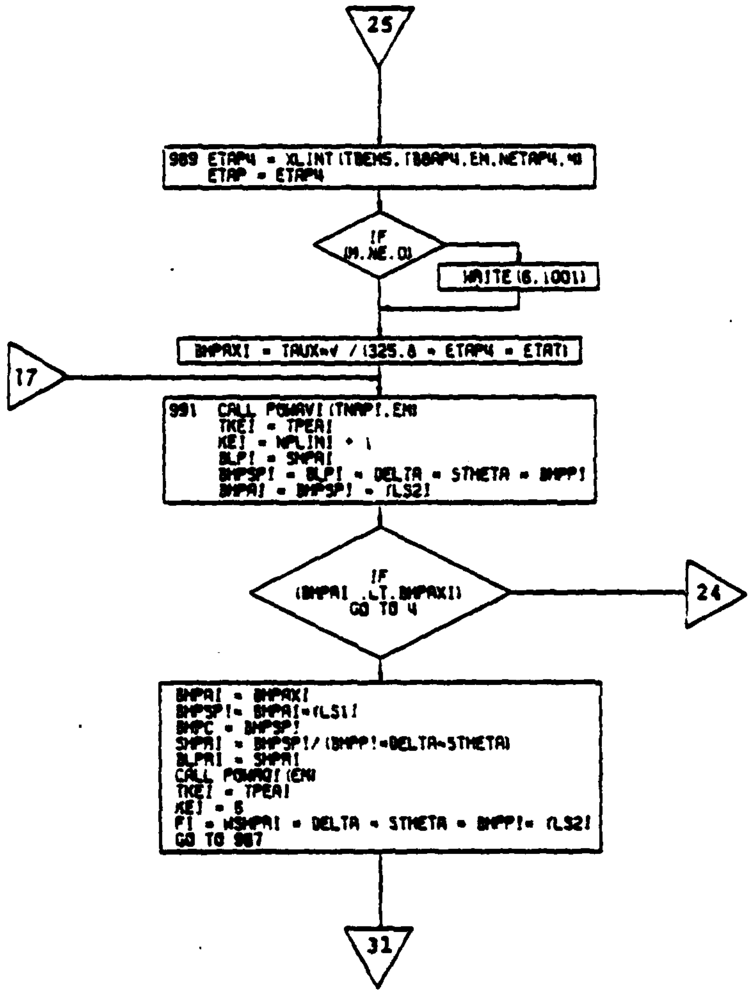


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 7 of 10)

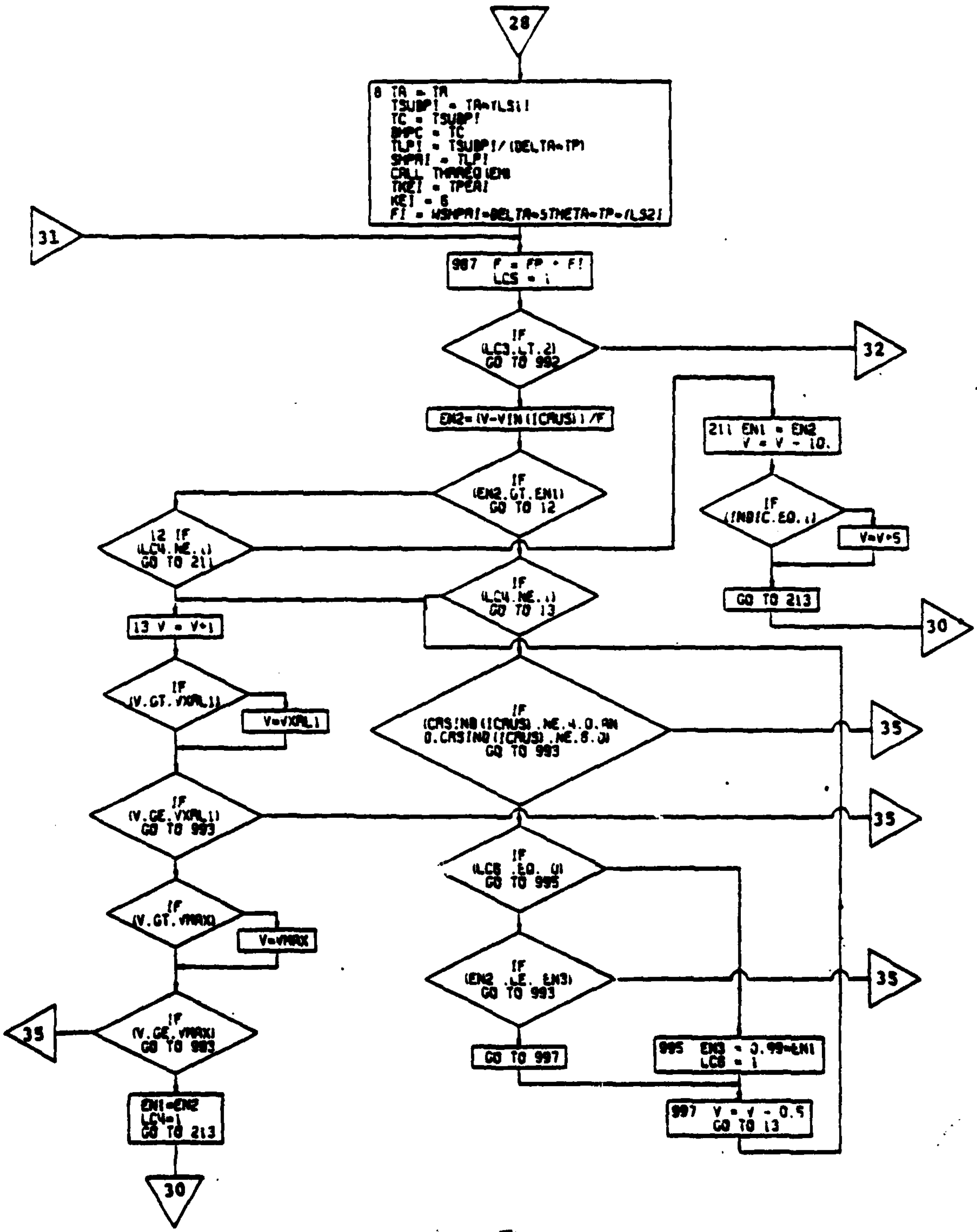


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 8 of 10)

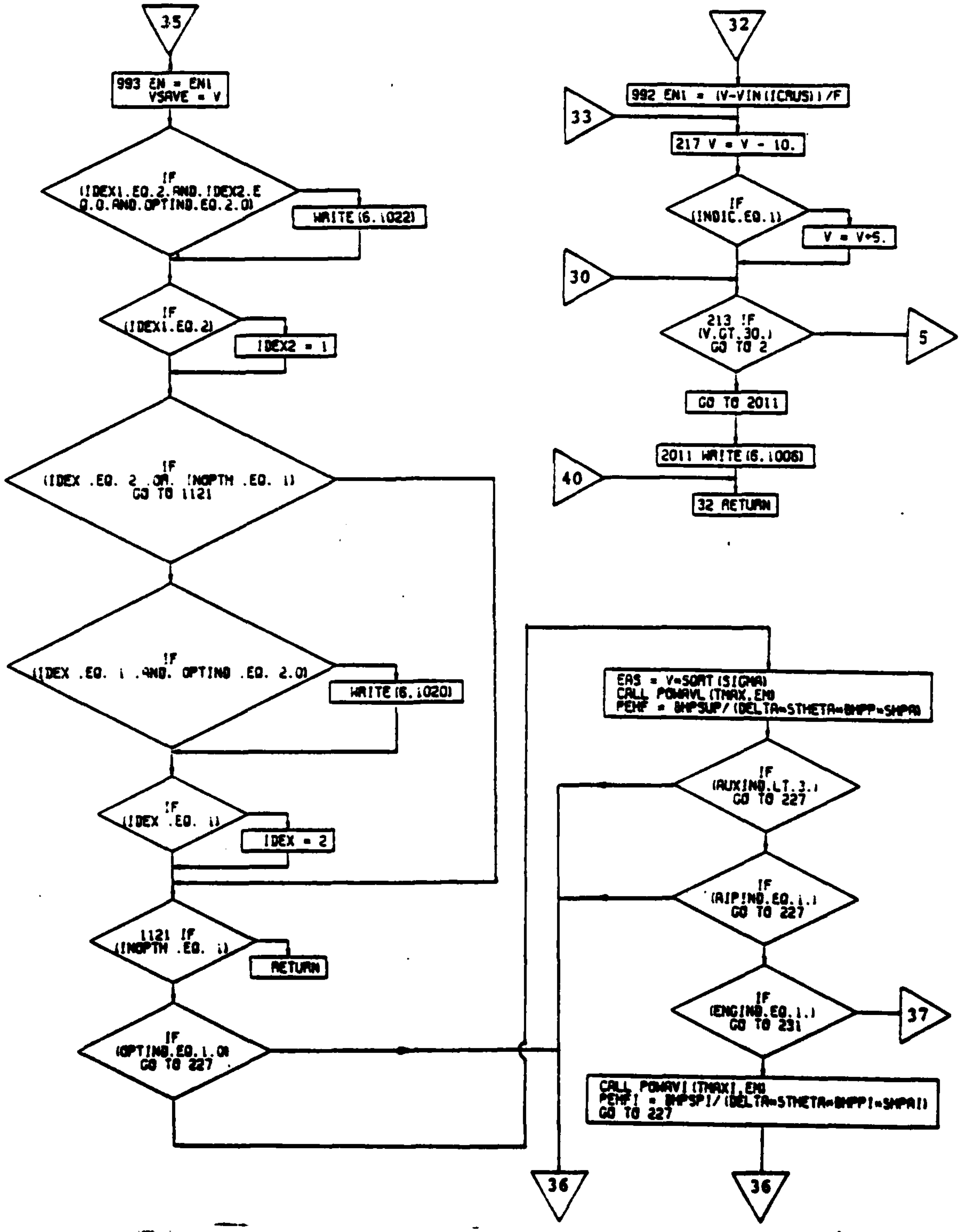


Figure 4-52d. ~~Cruise~~ 3 Subroutine, Flow Chart (Part 9 of 10)

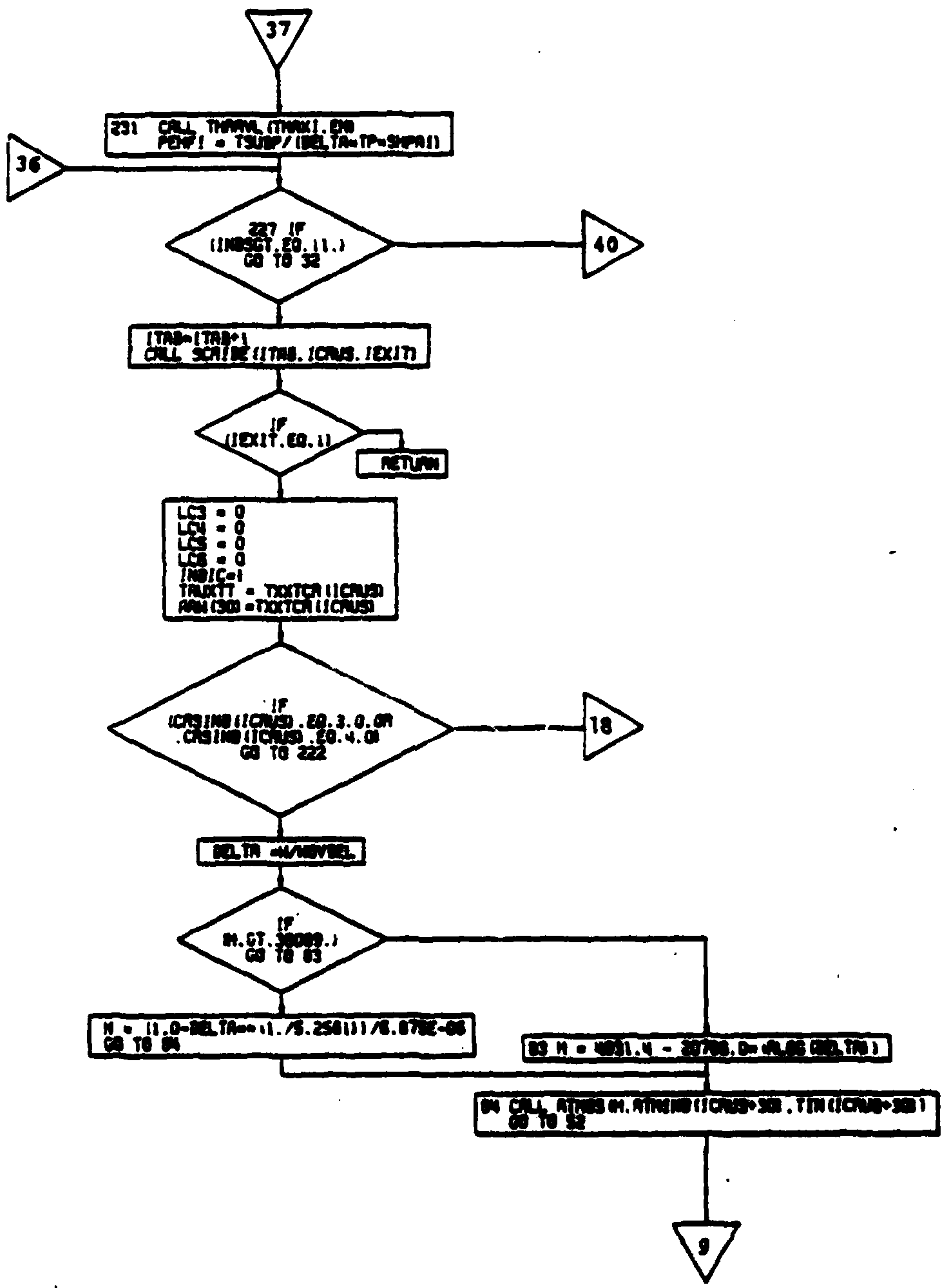


Figure 4-52d. Cruise 3 Subroutine, Flow Chart (Part 10 of 10)

4.12.5 Descent Calculations Subroutine

Twelve different options for descent performance calculation are available. The options fall into three different categories: descent at constant true air speed (TAS), descent at constant equivalent air speed (EAS), and descent at constant Mach number. In addition, each type of descent may be calculated for a specified type of descent flight path, specified by RMAXND as follows:

Value of RMAXND	Type of Flight Path
0	Descent flight path ends at specified terminal range.
1	Program checks terminal range requirement, but does not match it.
2	Descent flight path ends at a specified minimum altitude, the terminal range requirement not being considered.
3	Fuel used and time required for descent are calculated, but no range credit is given (i.e., spiral descent path).

Rate of descent (R/D) is always input. If the airspeed-rate of descent combination (as specified by DESIND) exceeds the descent boundaries, the airspeed will be held constant, while the R/D is adjusted accordingly. Figure 4-47 in which R/D is plotted against flight speed, illustrates the descent boundaries. They are:

(a) Vertical rate of descent boundary

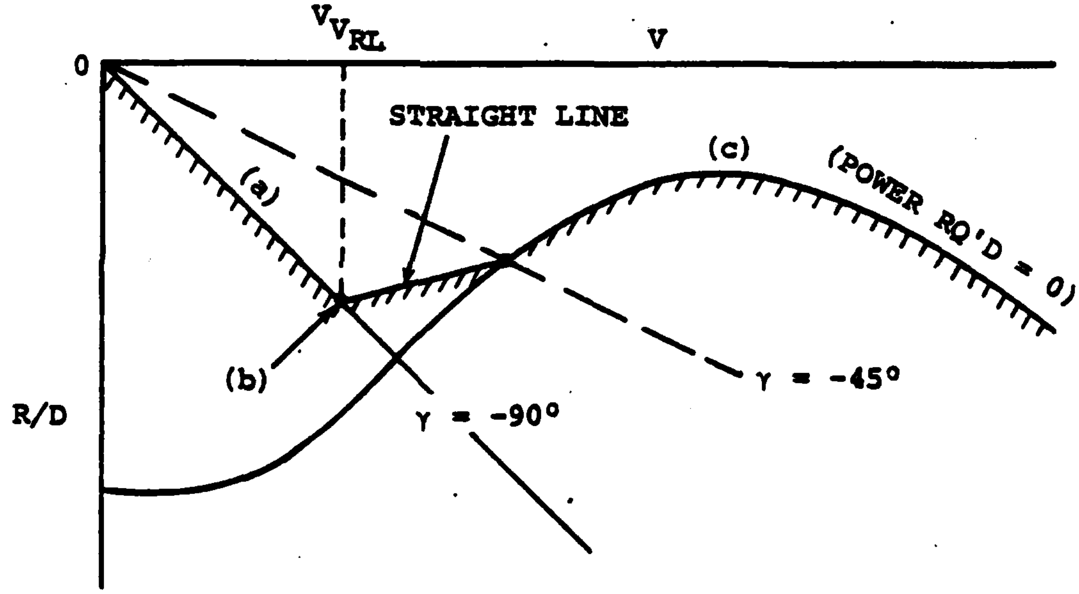
$$(\gamma = -90^\circ)$$

(b) V_{VRL} (vortex ring state) limit descent speed - defined by the equation

$$V_{VRL} = \frac{2}{3}\sqrt{\frac{T}{2\rho A}}$$

where T = total rotor thrust
A = disc area.

(c) Autorotative descent (power required = 0).



(a) Vertical rate of descent boundary
(b) Vortex ring state limit descent speed
(c) Autorotative descent boundary

Figure 4-53. Descent Boundaries.

The distinction between the first type of descent flight path (as specified by RMAXND = 0) and the last three (RMAXND = 1, 2, 3) in regard to the range at which the descent starts, when terminal range is specified, should be clearly understood.

a. If RMAXND = 0, no spiral descent path is permitted. The program will calculate the value for range at the beginning of the descent which is required to satisfy the terminal condition on range and altitude. In order to do this, the program "backs up" on the previous segment. If this option (RMAXND = 0) is used, the descent must be preceded by a cruise segment. The input value for maximum range for the preceding cruise segment is a dummny value and the cruise will actually terminate, in order to begin descent, at an earlier point. It is recommended, however, that when the RMAXND = 0 option is to be used, the maximum range during the preceding cruise be input as the same value as the terminal range at the end of the following descent.

b. If RMAXND = 1, the descent will start at the current value for range and, as previously described, the aircraft will fly a straight-line path to the desired terminal point. If the predicted flight path (as checked against the specified terminal range by the program) ends beyond the specified terminal range, a spiral descent path from the altitude at that point to the final altitude is assumed. If the predicted flight path ends before reaching the specified terminal range point, the program prints "SHALLOWER DESCENT REQUIRED". The descent may follow any other segment (climb, cruise, etc.) or may start the mission.

c. If RMAXND = 2 or 3, the descent will start at the current value for range; and, depending on the option chosen, will either end at the minimum altitude (RMAXND = 2) specified, with no constraint on the resulting range, or a spiral descent path (RMAXND = 3) will be assumed. As with RMAXND = 1, the descent options may follow any other segment, or may start the mission.

An increment in aircraft parasite drag may be input in order to simulate the effects of dive brakes, external stores, etc. It is possible to use a descent segment in the mission profile to account for a reserve fuel requirement (SGTIND = 50)(in such a case the helicopter weight at the end of descent is set back to the weight at the beginning of descent) or as a part of the basic mission (in this case the weight is not reset). In either case, the fuel used during descent is included in the total fuel required to size the helicopter.

Input to the subroutine consists of the settings for DESIND

and RMAXND, atmospheric conditions, R/D, the propulsive thrust split, the incremental parasite drag, the operating wing lift coefficient (winged and compound helicopters), the final altitude, the step size, the required TAS, EAS or Mach number, the terminal range requirement (RMAXND = 0, 1) and the number of engines shut down. Subroutine DESPOW (which is called by the Descent calculations subroutine) calculates the power required for descent at the desired flight conditions. Figure 4-54 is a flow chart of subroutine DESPOW and Figure 4-55 is a flow chart of the descent calculations subroutine.

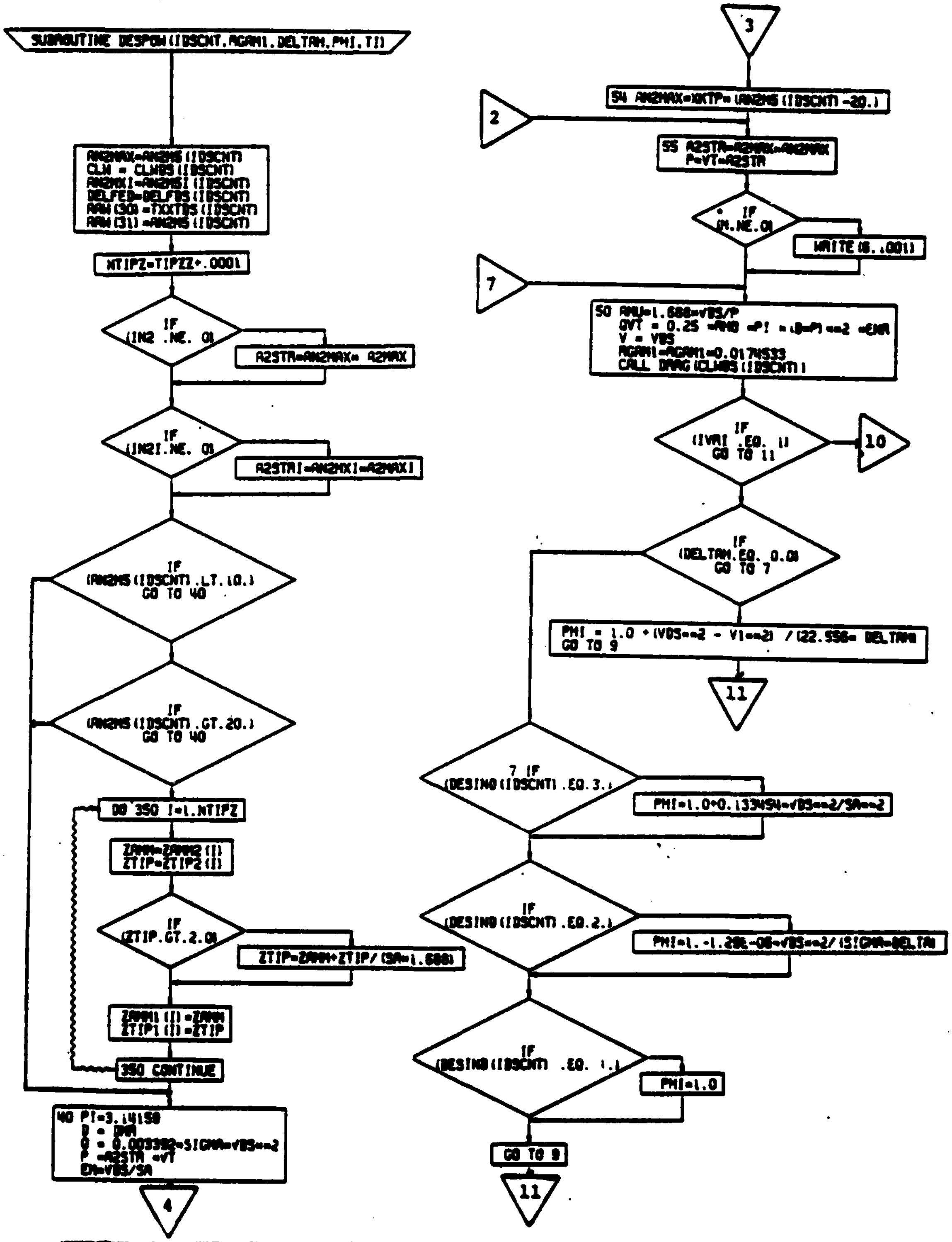


Figure 4-54. DESPOW Subroutine, Flow Chart (Part 1 of 3)

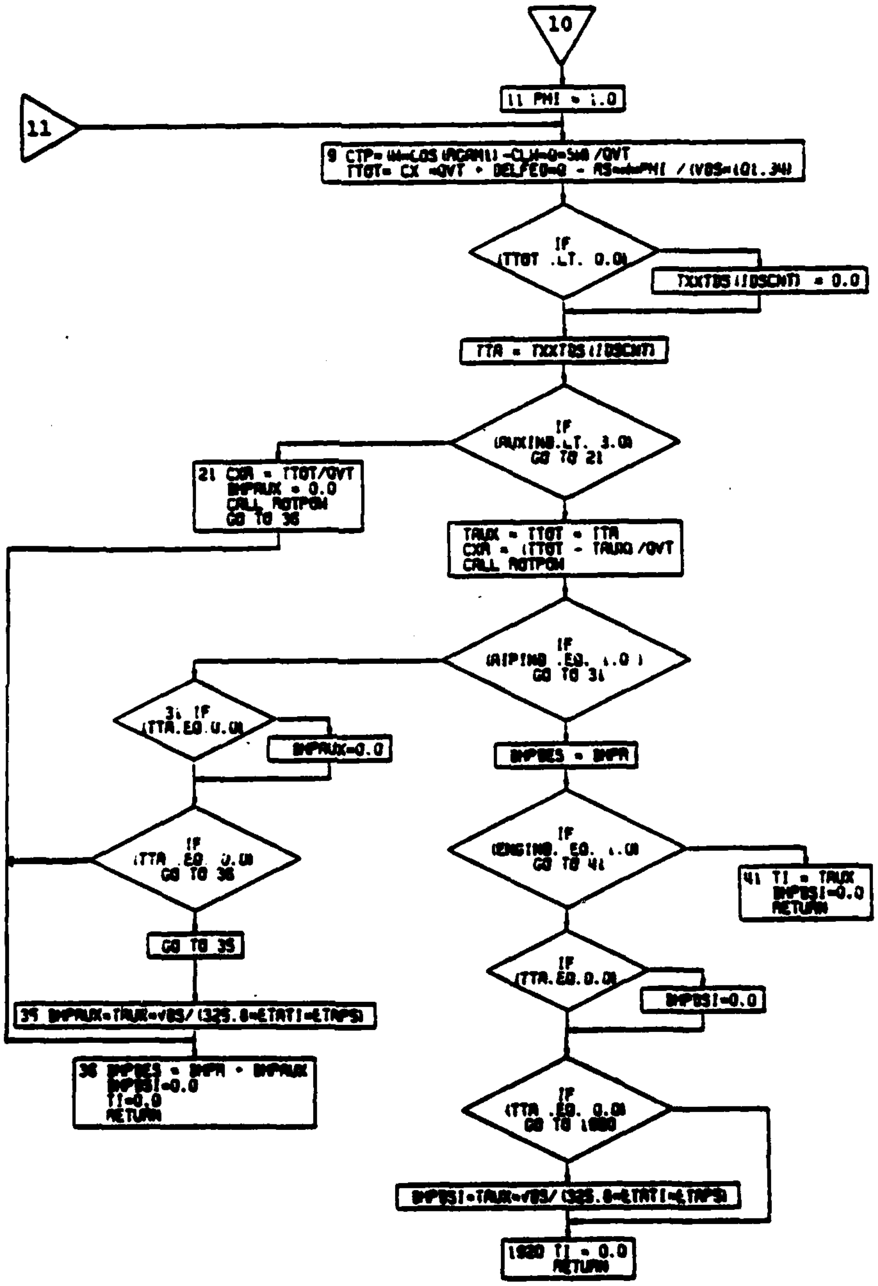


Figure 4-54. DESPOW Subroutine, Flow Chart (Part 2 of 3)

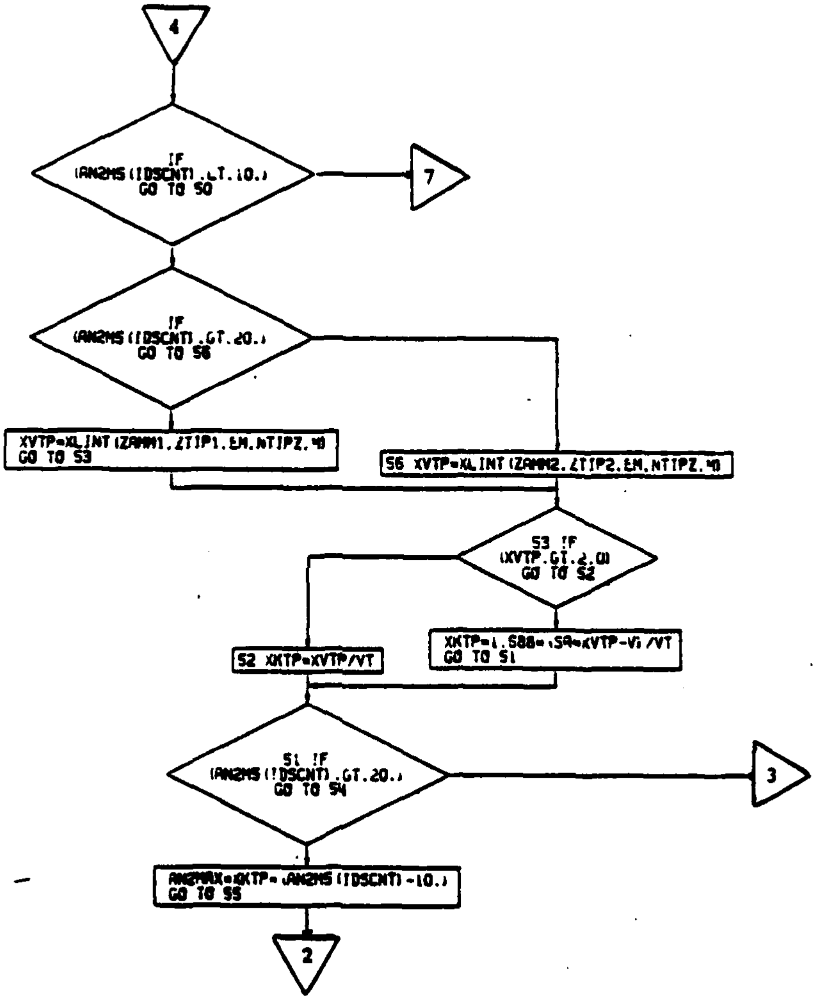


Figure 4-54. DESPOW Subroutine, Flow Chart (Part 3 of 3)

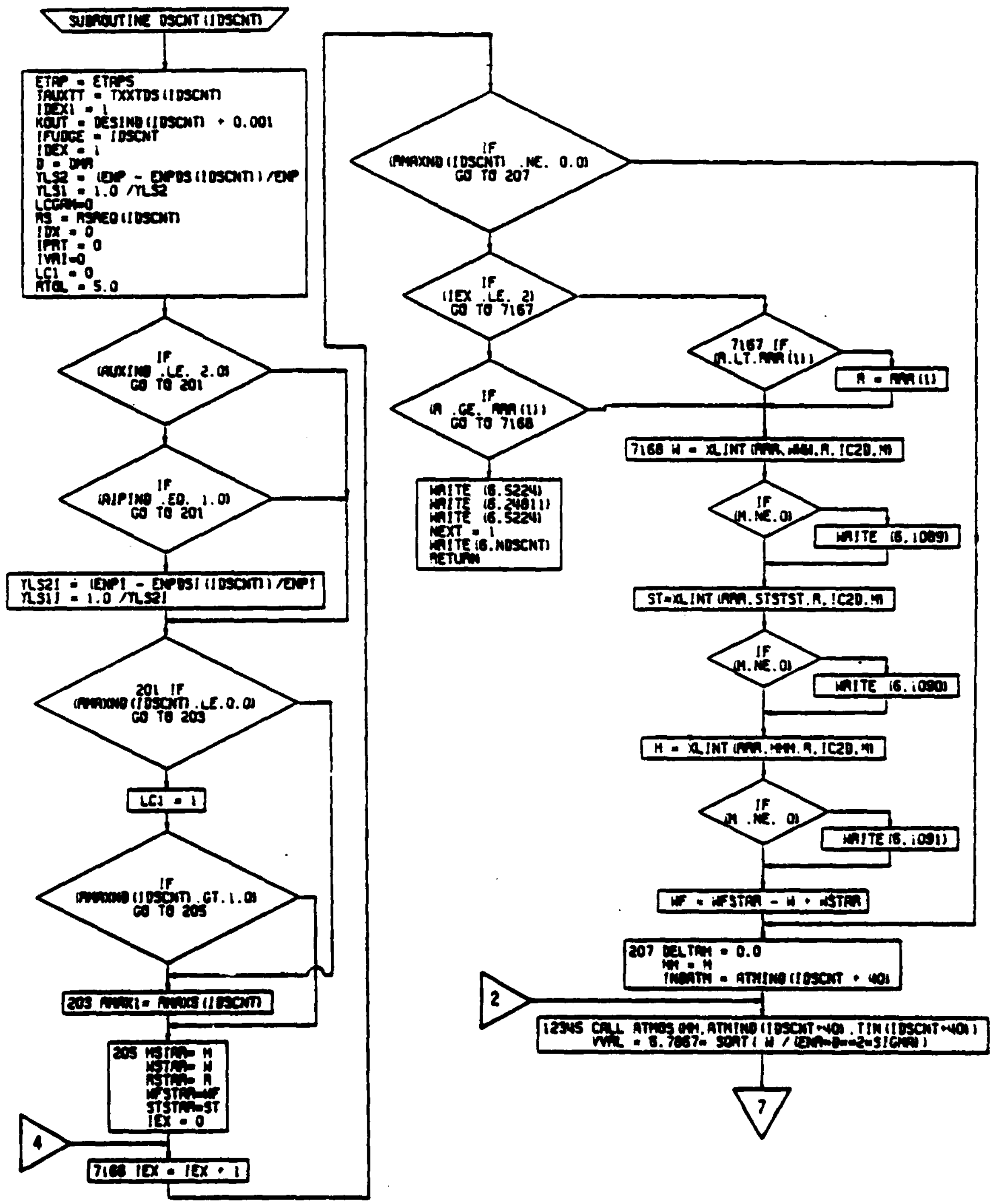


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 1 of 10)

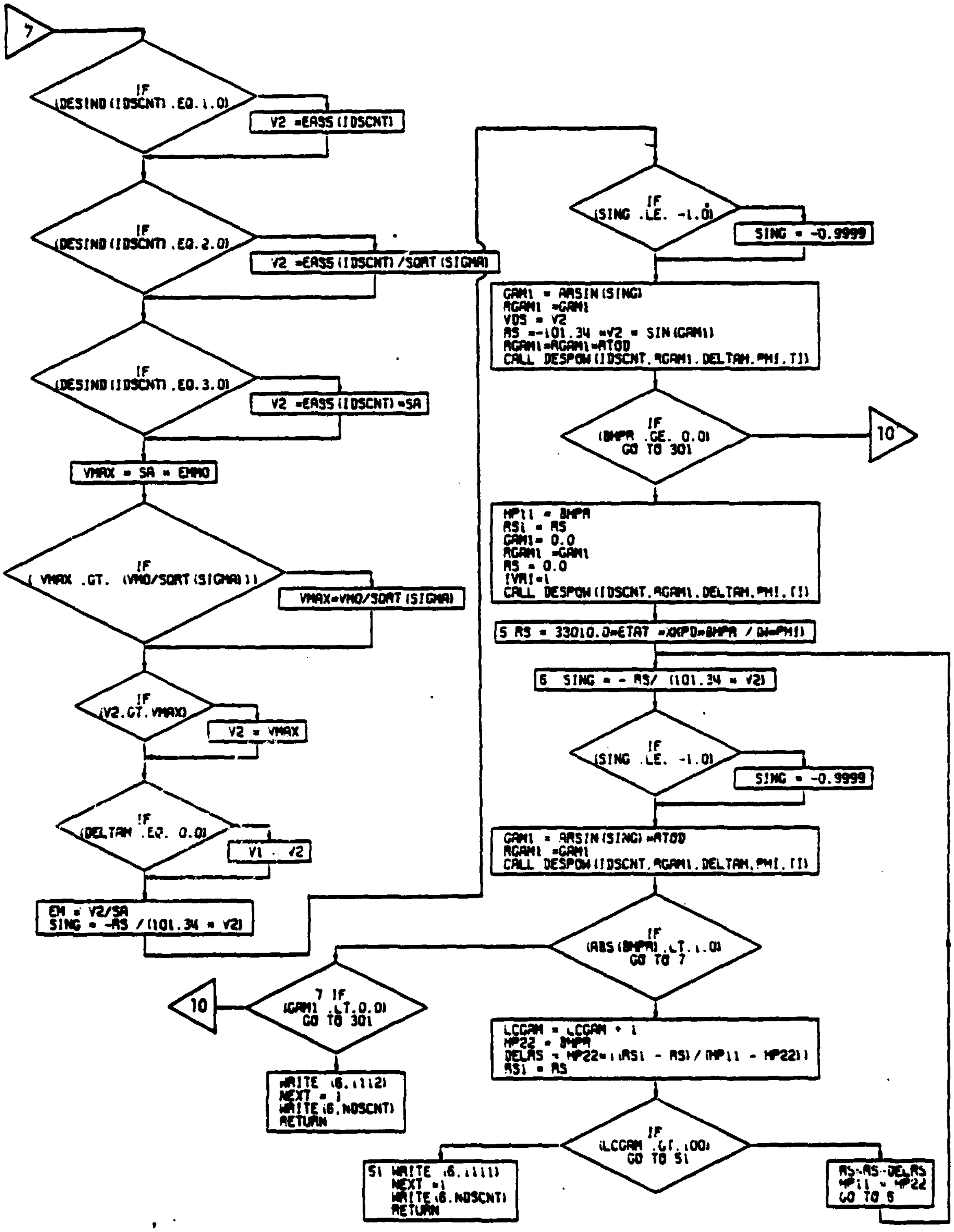


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 2 of 10)

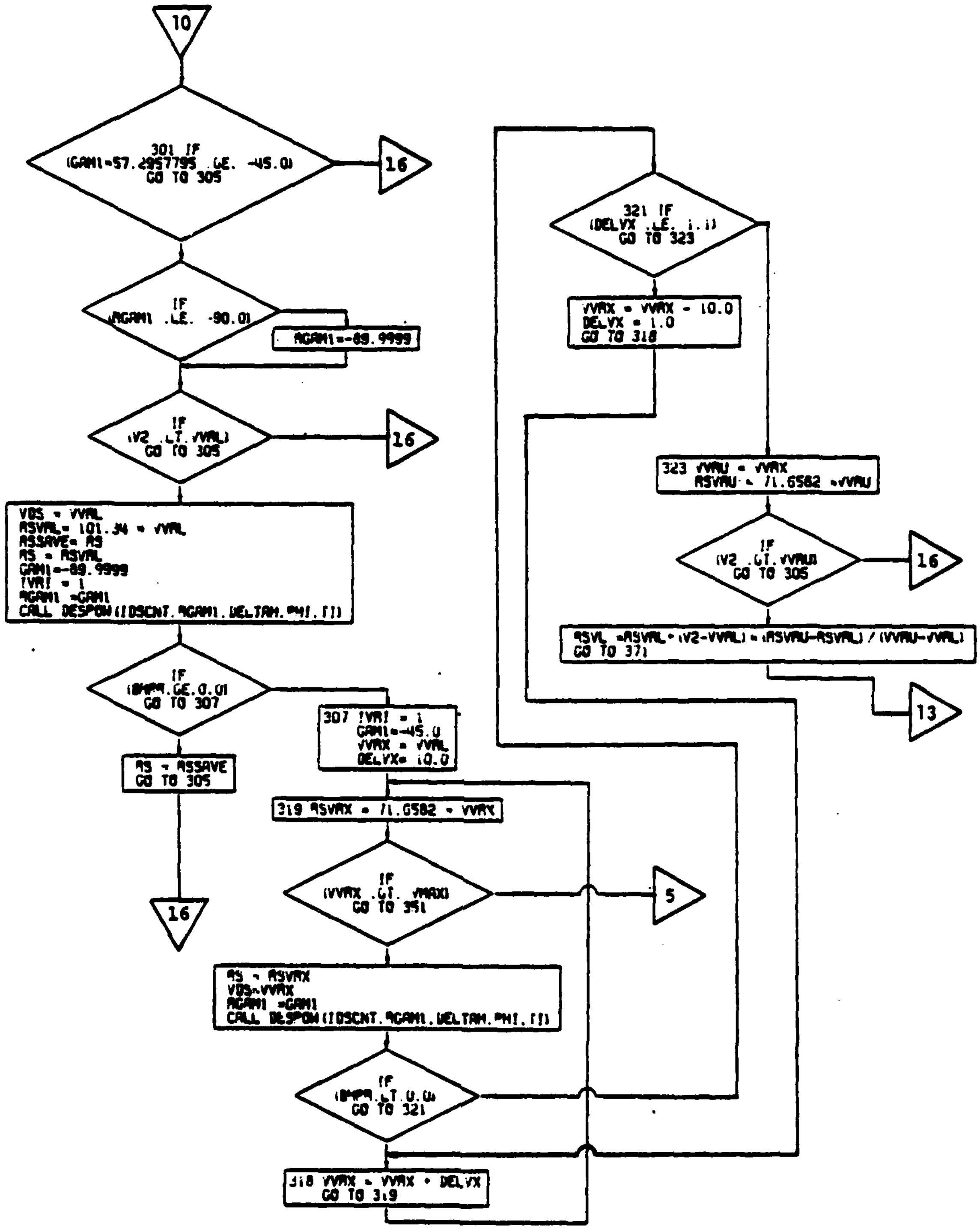


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 3 of 10)

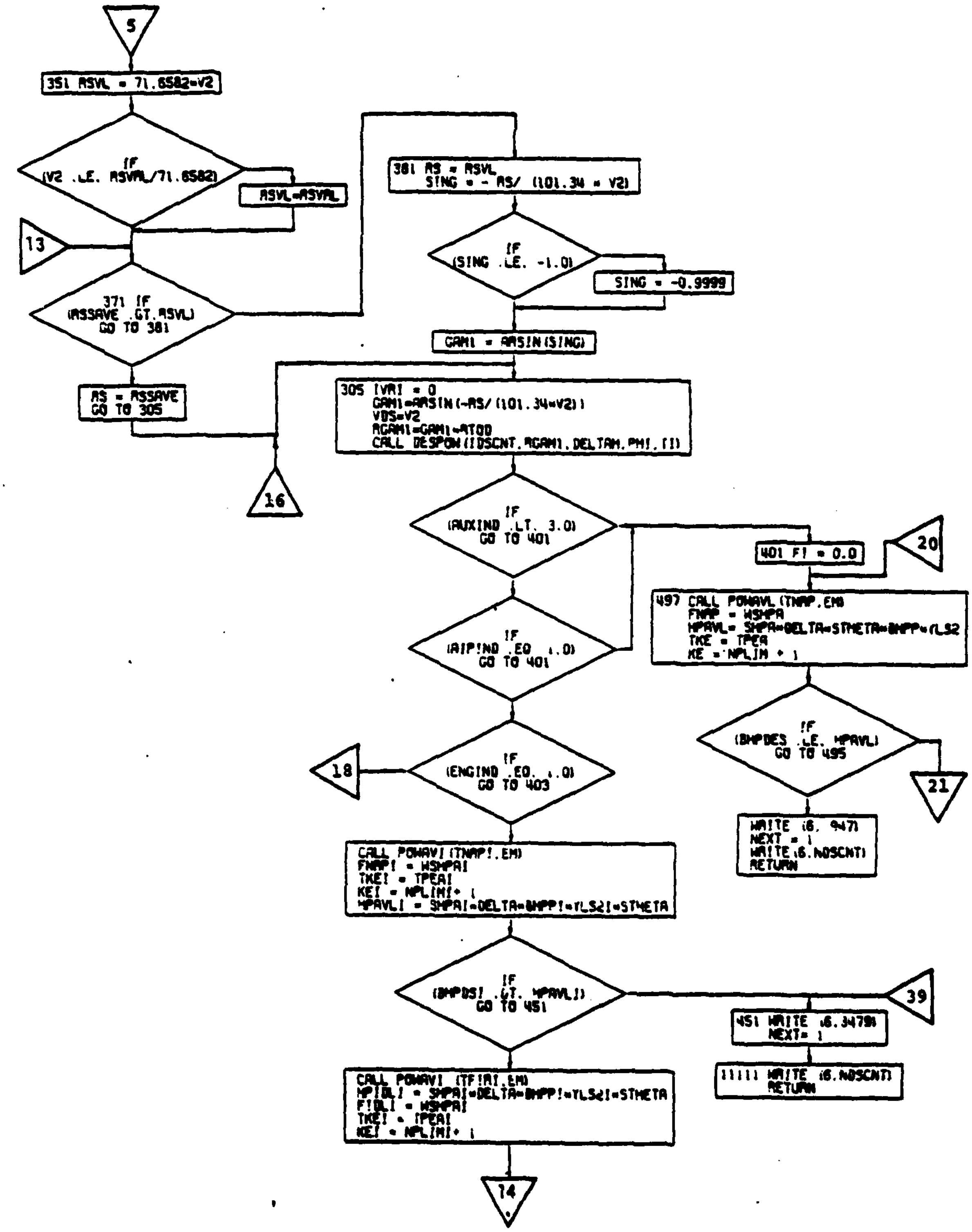


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 4 of 10)

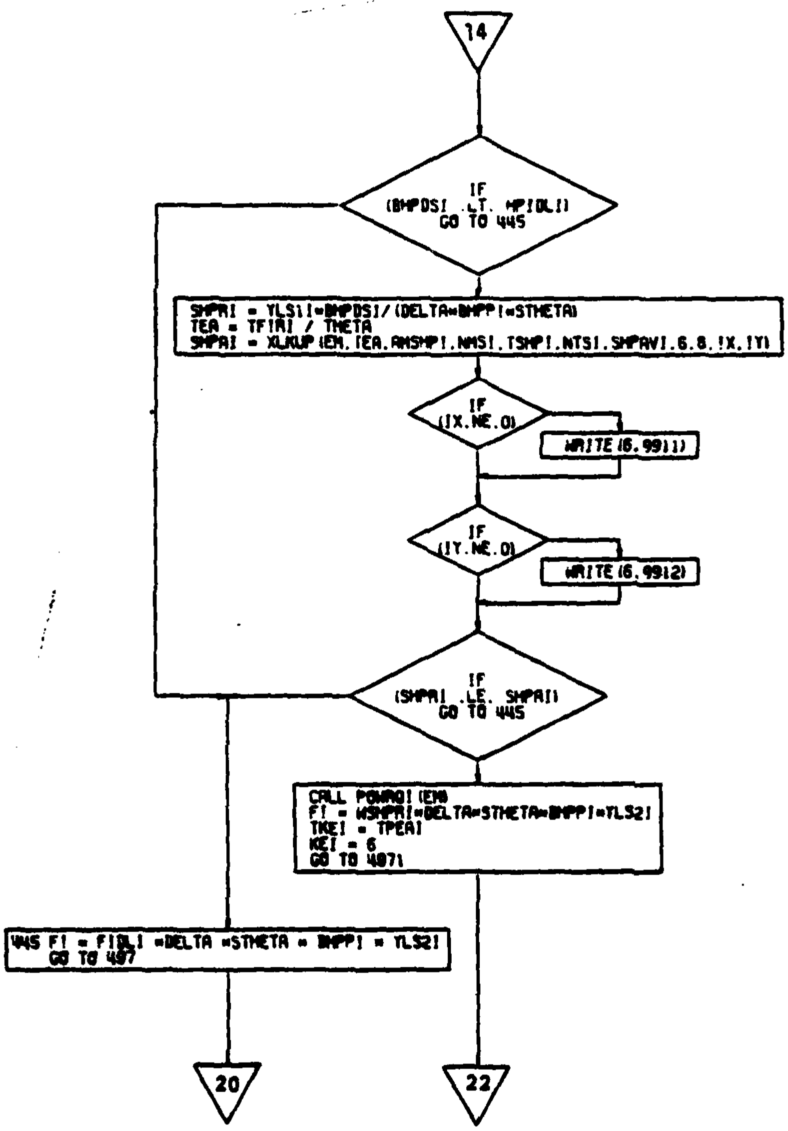


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 5 of 10)

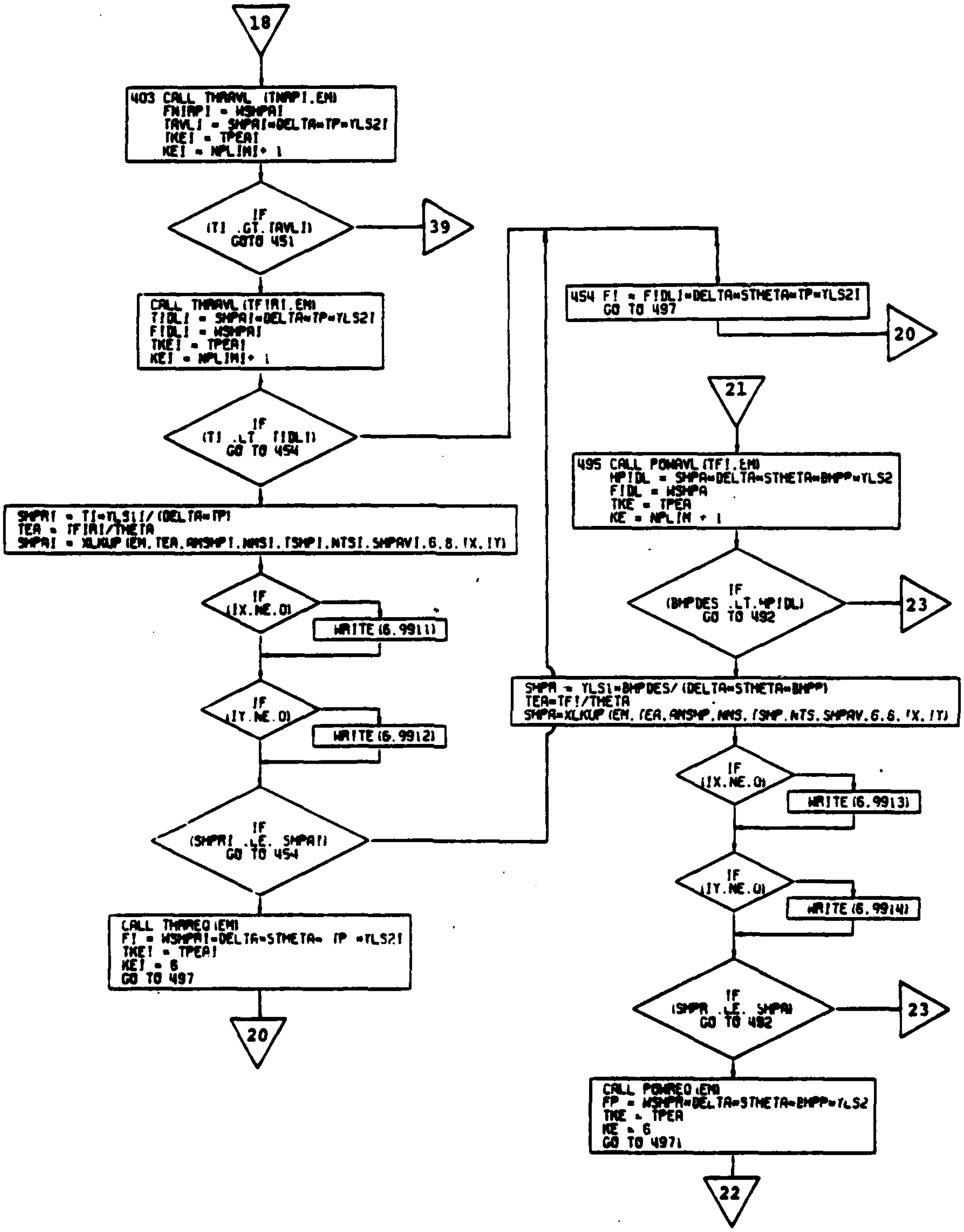


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 6 of 10)

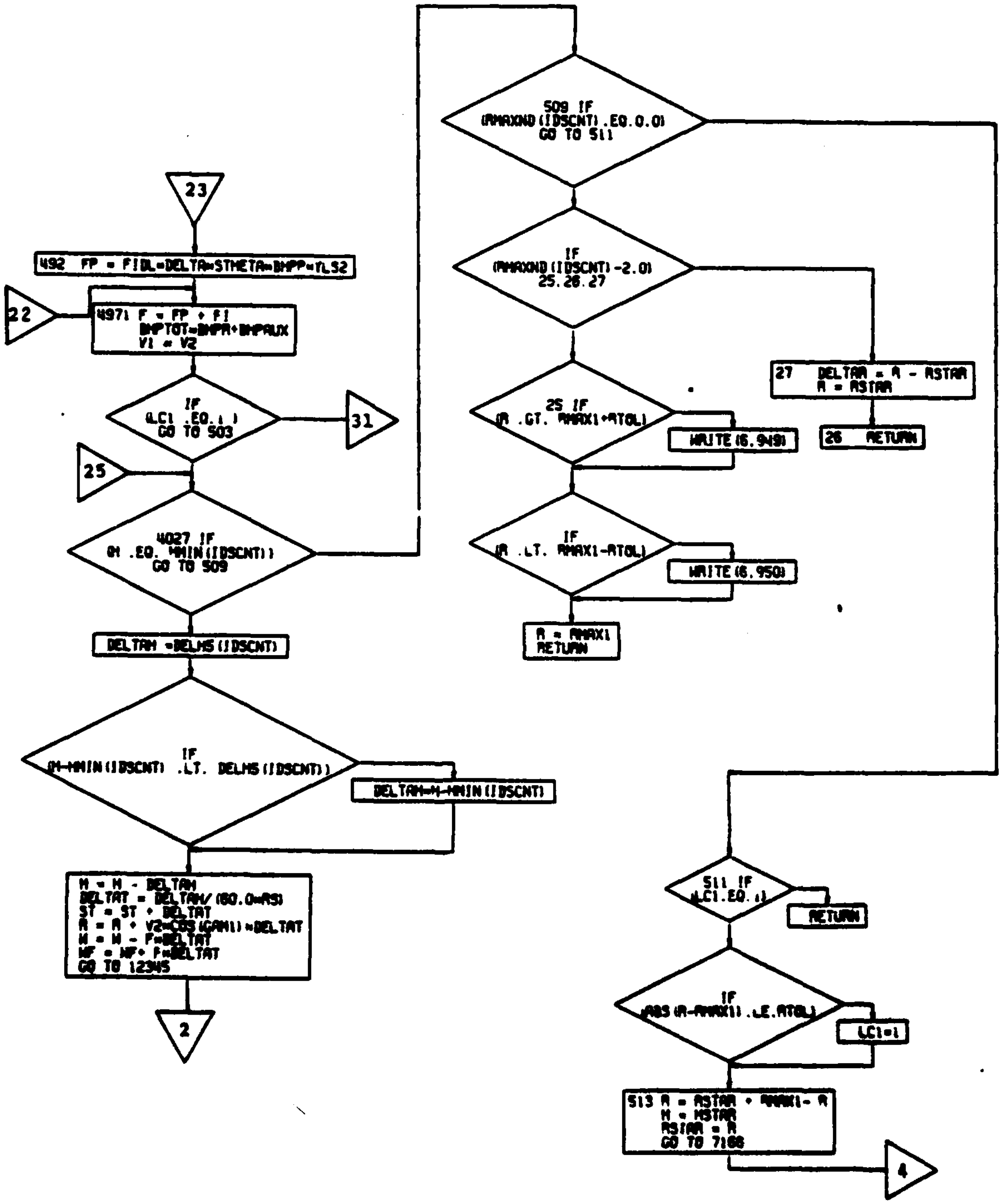


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 7 of 10)

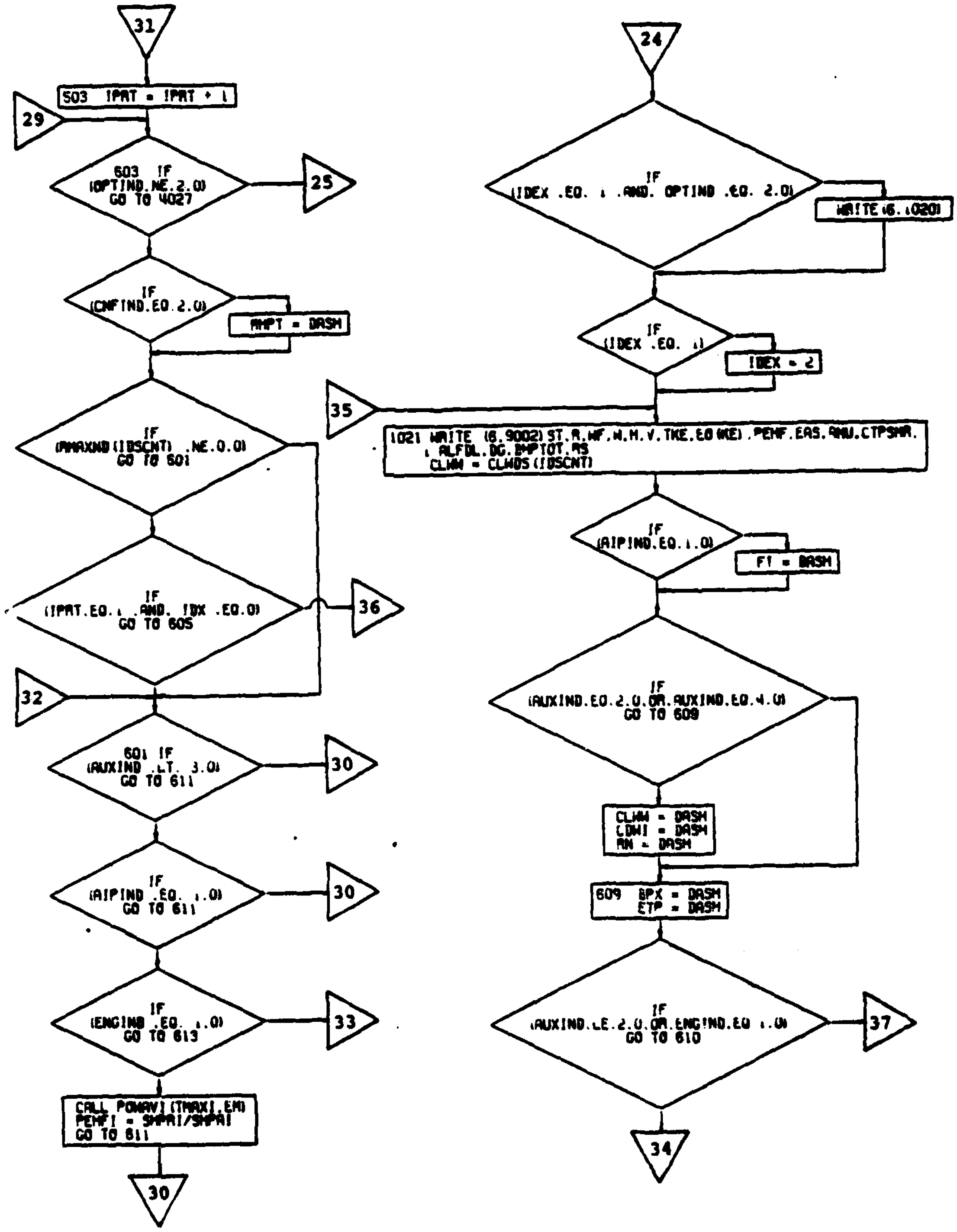


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 8 of 10)

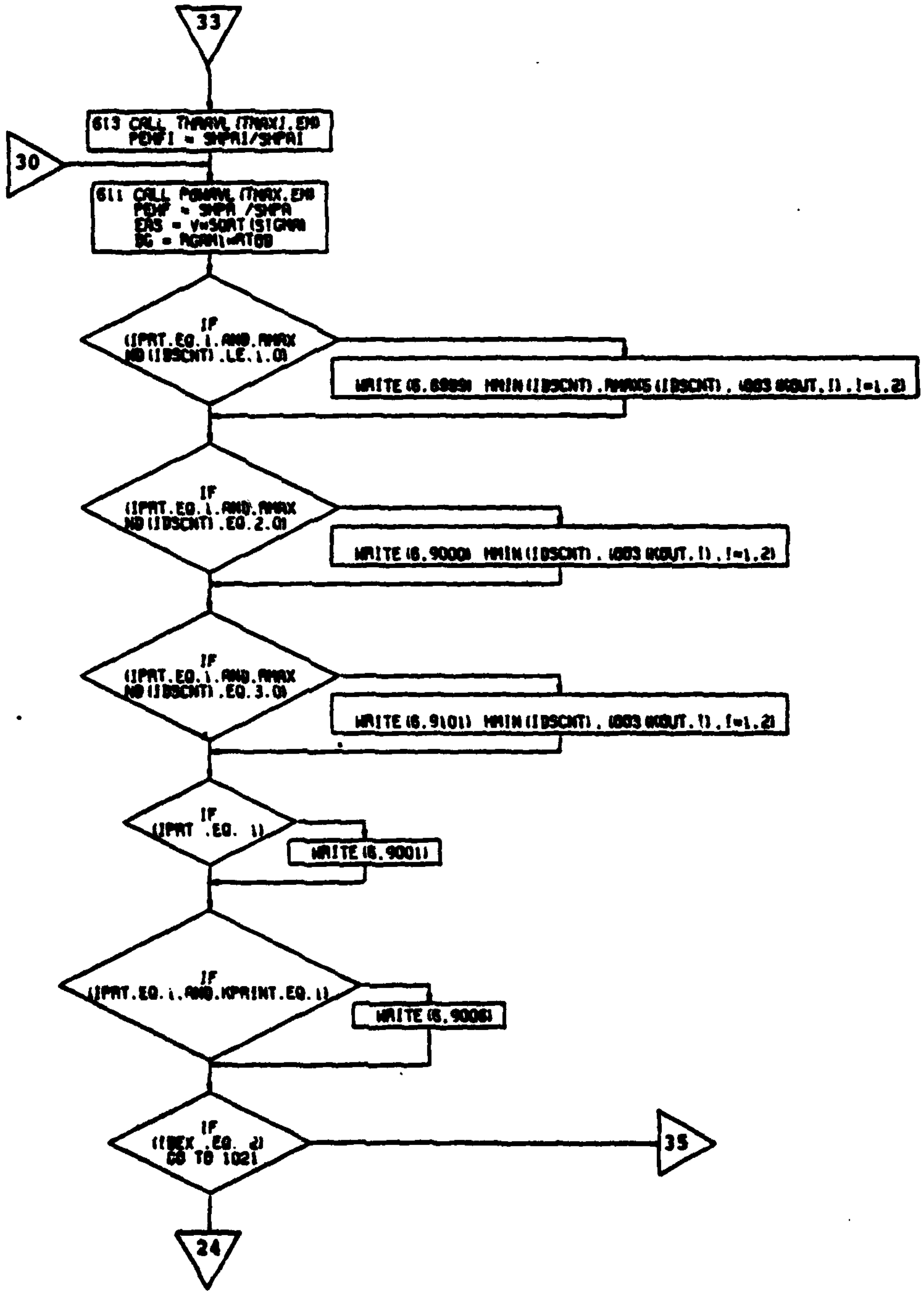


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 9 of 10)

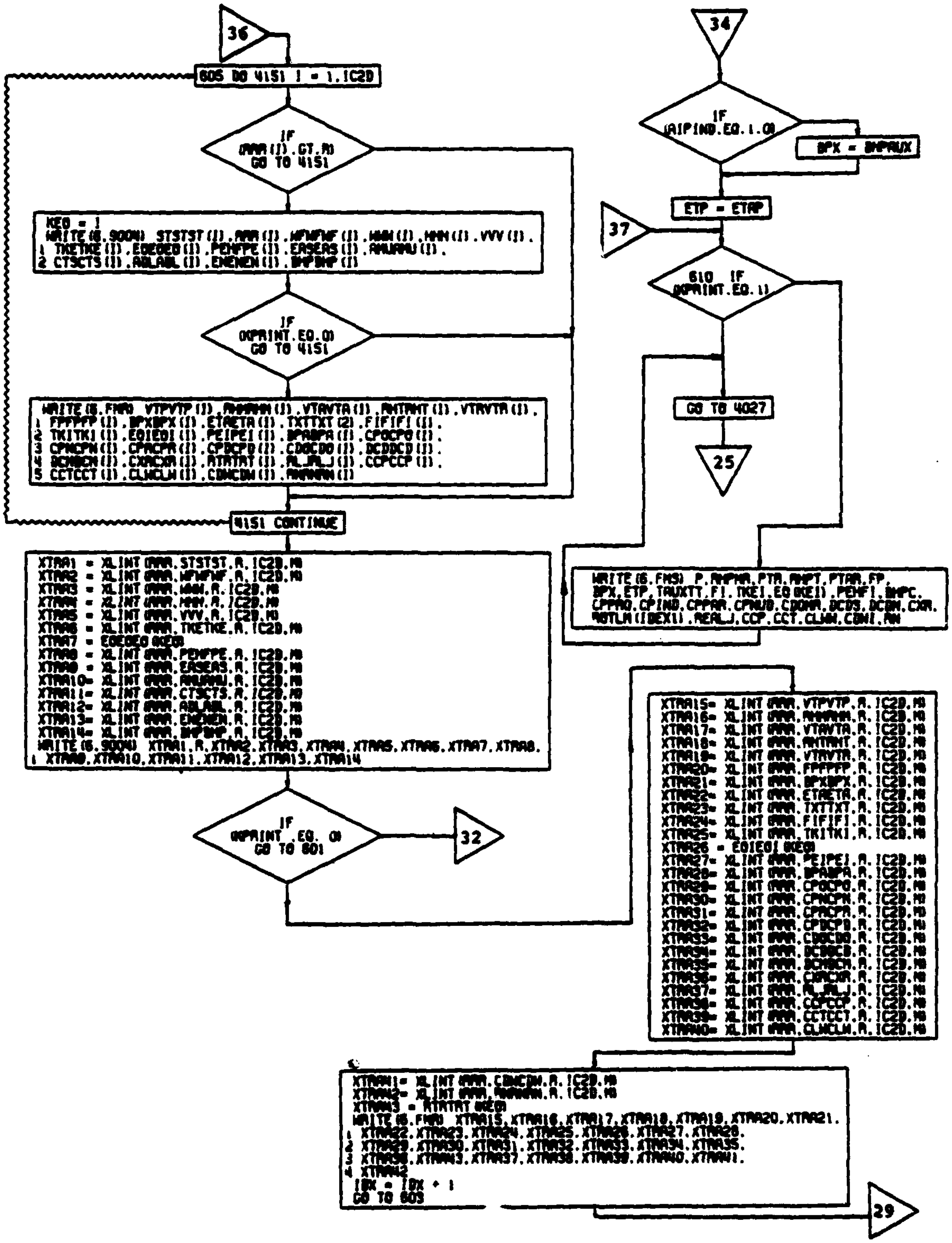


Figure 4-55. DSCNT Subroutine, Flow Chart (Part 10 of 10)

4.12.6 Loiter Calculations Subroutine

The sixth performance segment represents a calculation of helicopter loiter performance. In this subroutine, the helicopter will fly at the airspeed for best endurance. This subroutine calculates the power required and the airspeed to maximize the endurance of the helicopter. It also determines the fuel required to loiter for a specified period of time.

Engine shutdown during loiter may be simulated by inputs for N_{PSD} (primary engines) and N_{PSDi} (auxiliary independent engines). One or more engines may be shutdown. A increment in helicopter drag (ΔFe_{LOITER}) may be input to represent drag changes due to external stores, windmilling propellers (in the case of a compound helicopter using propellers), etc.

For a compound helicopter, the split of propulsive thrust required between the main rotor and the auxiliary propulsion system may be specified by an input for (T_{AUX}/T_{TOT}).

It is possible to use a loiter segment in the mission profile to account for a reserve fuel requirement (SGTIND = 60) (in such case the helicopter weight at the end of loiter is set back to the weight at the beginning of loiter) or as a part of the basic mission (in this case the weight is not reset). In either case, the fuel used during loiter is included in the total fuel required to size the helicopter.

The input to this subroutine consists of the time for loiter, step size (incremental time), the incremental parasite drag area, the number of engines (primary and auxiliary independent) shut down, the atmospheric conditions, the operating wing lift coefficient (in the case of compound and winged helicopters), and the propulsive thrust split. A flow chart of this subroutine is shown in Figure 4-56.

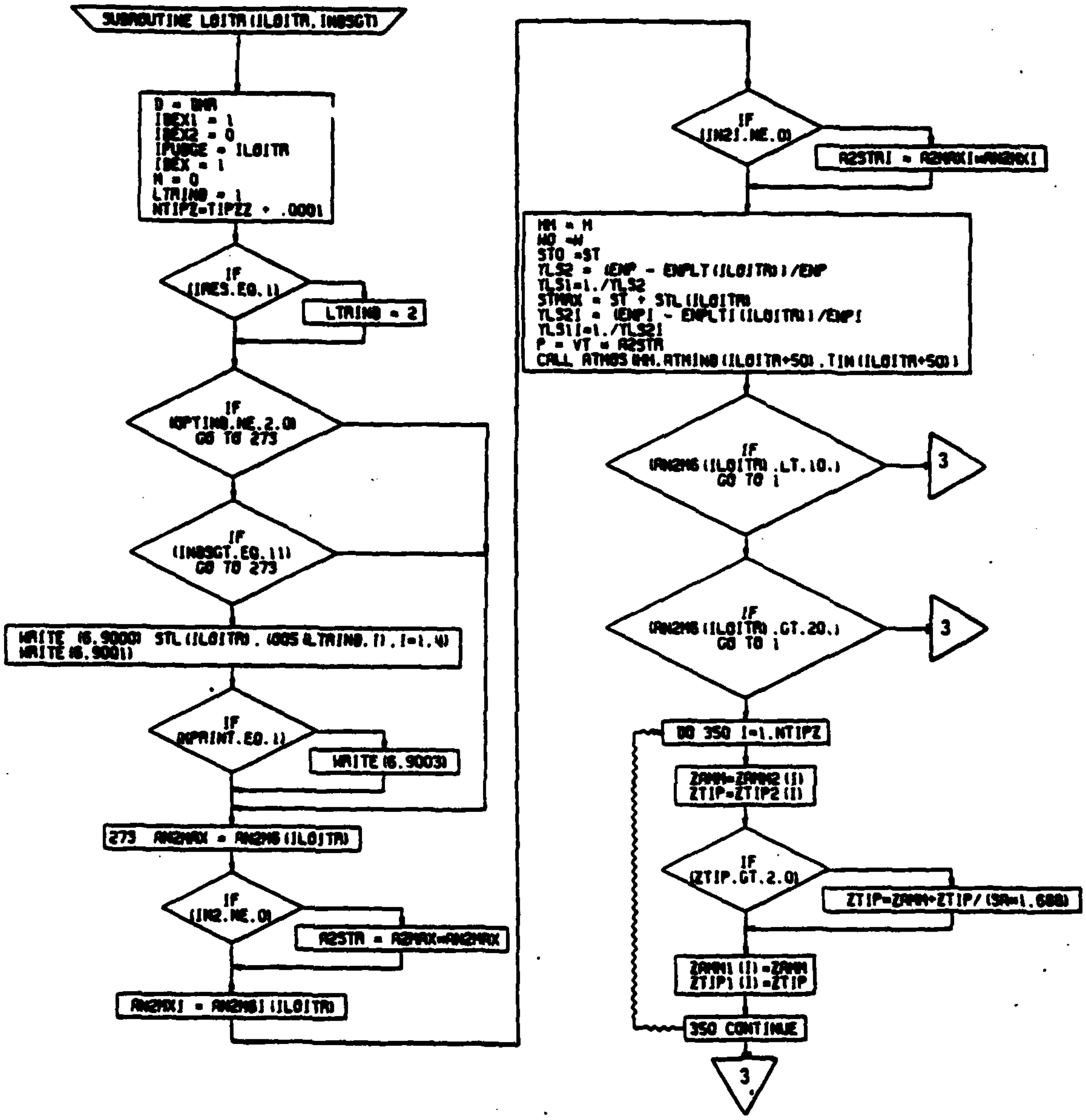


Figure 4-56. LOITR Subroutine, Flow Chart (Part 1 of 12)

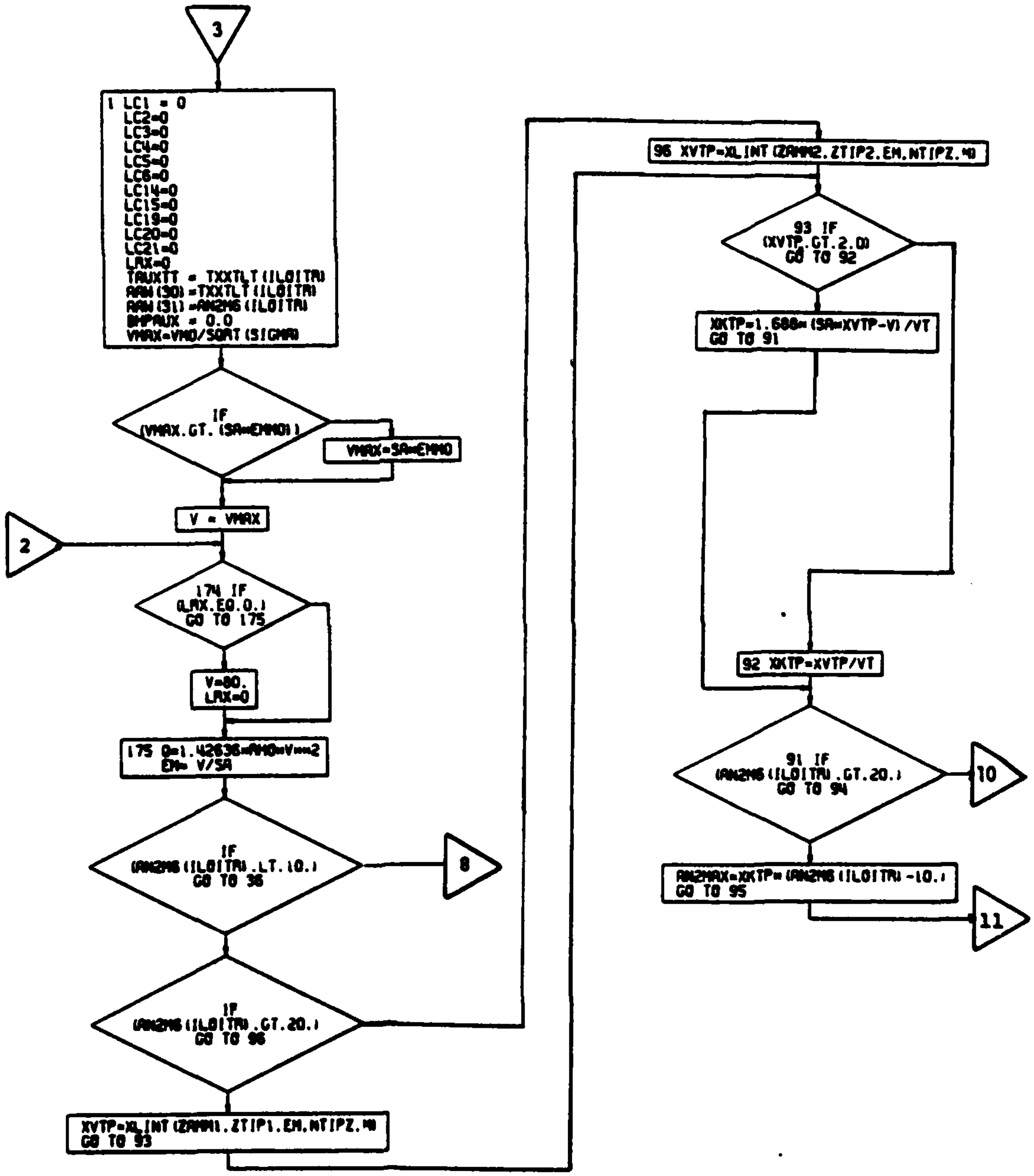


Figure 4-56. LOITR Subroutine, Flow Chart (Part 2 of 12)

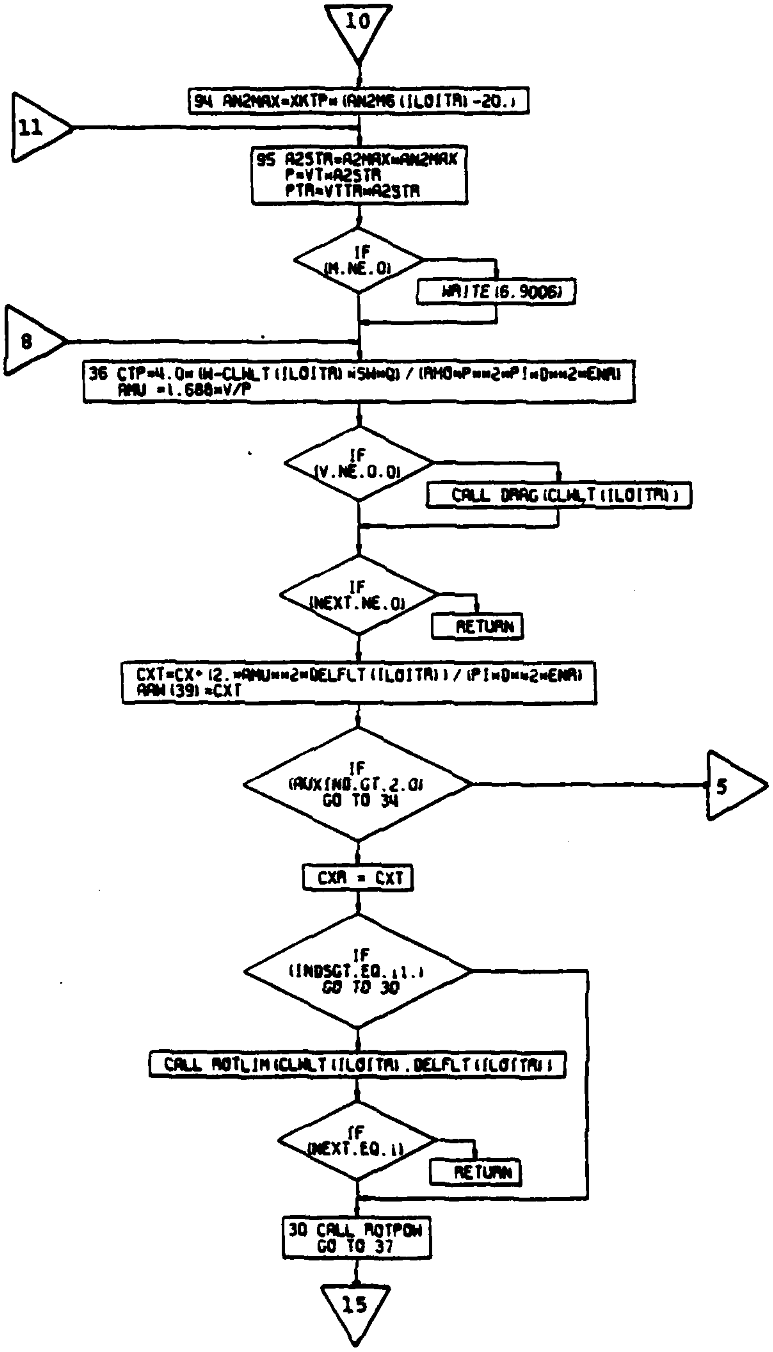


Figure 4-56. LOITR Subroutine, Flow Chart (Part 3 of 12)

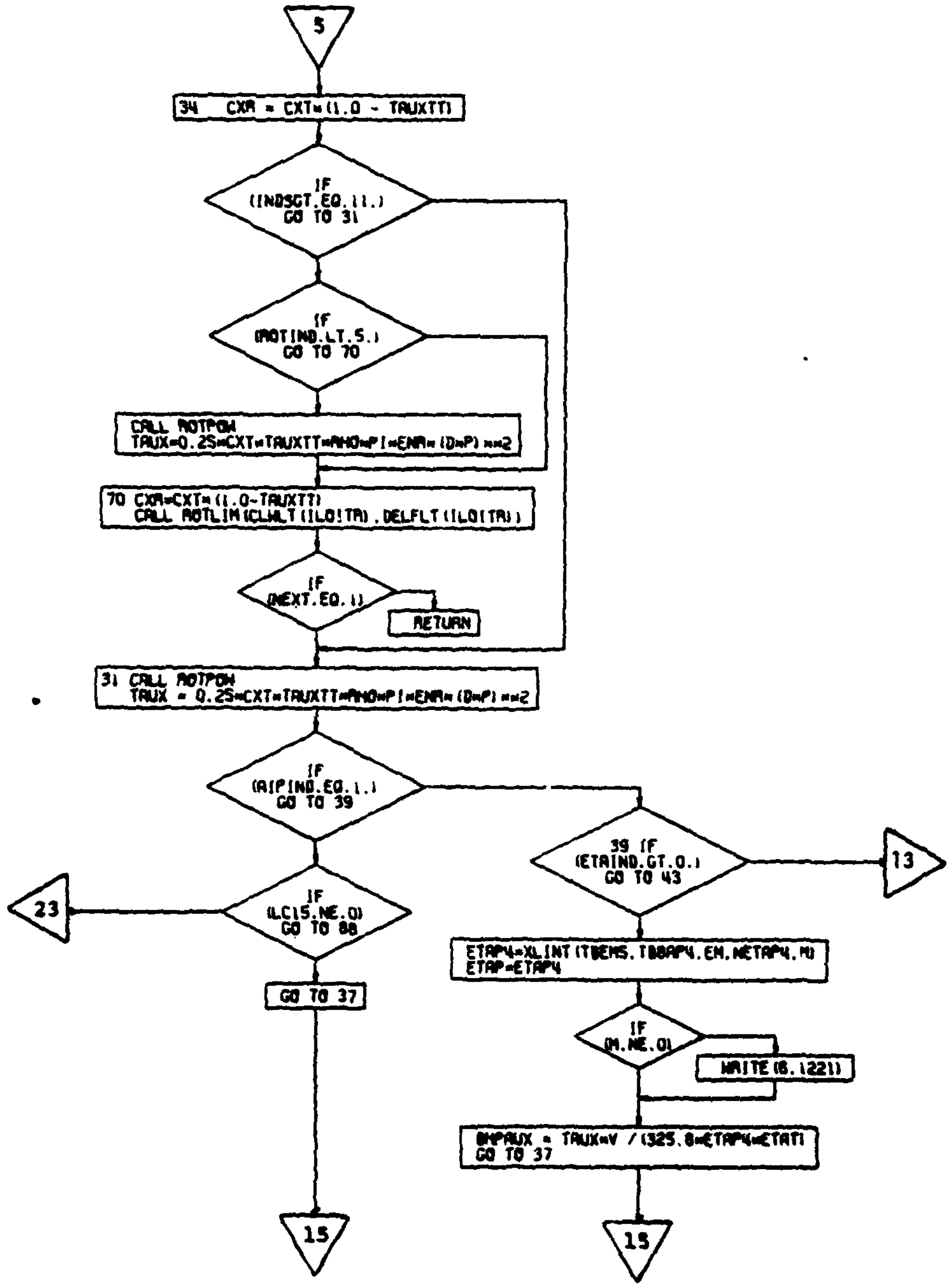


Figure 4-56. LOITR Subroutine, Flow Chart (Part 4 of 12)

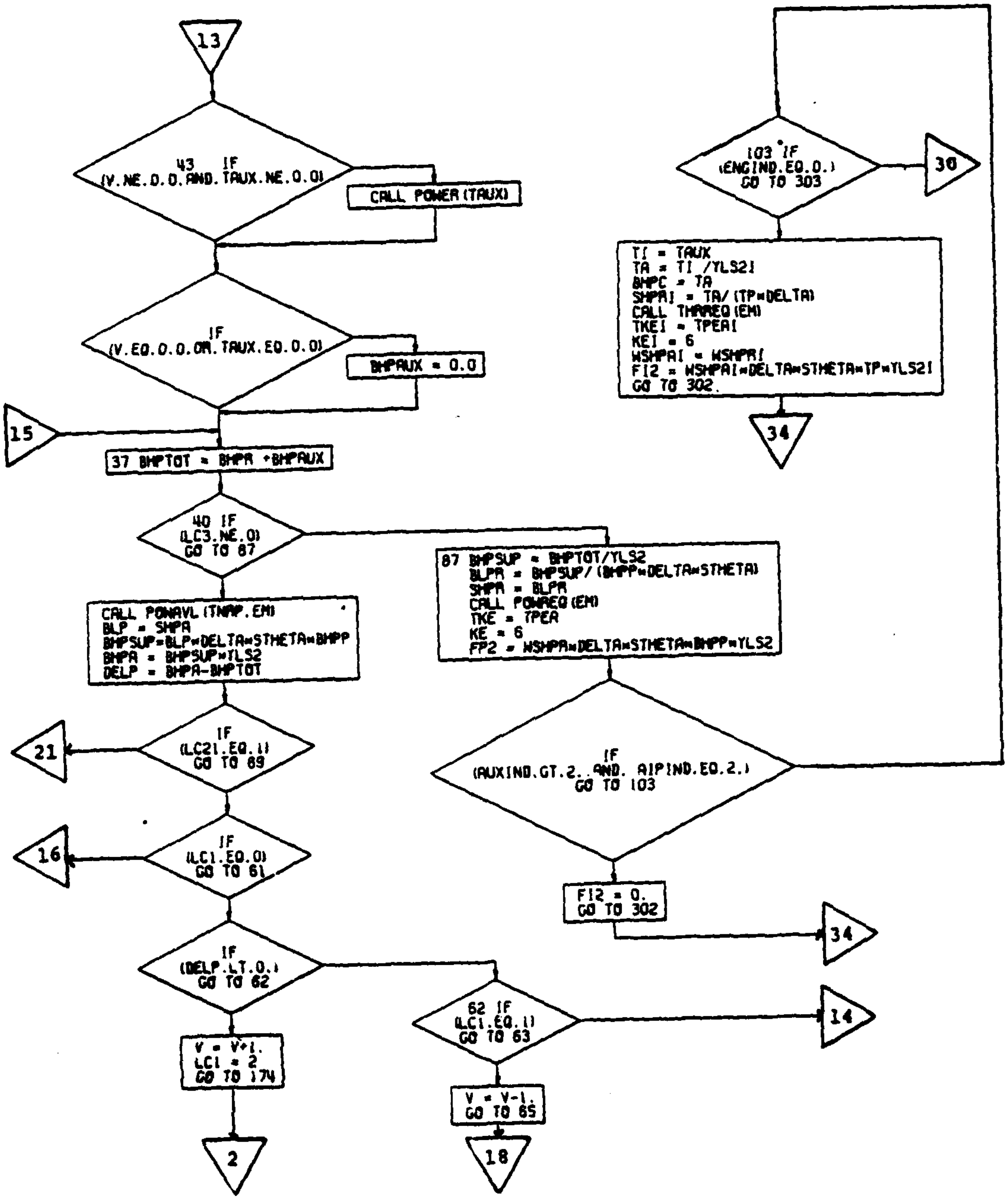


Figure 4-56. LOITR Subroutine, Flow Chart (Part 5 of 12)

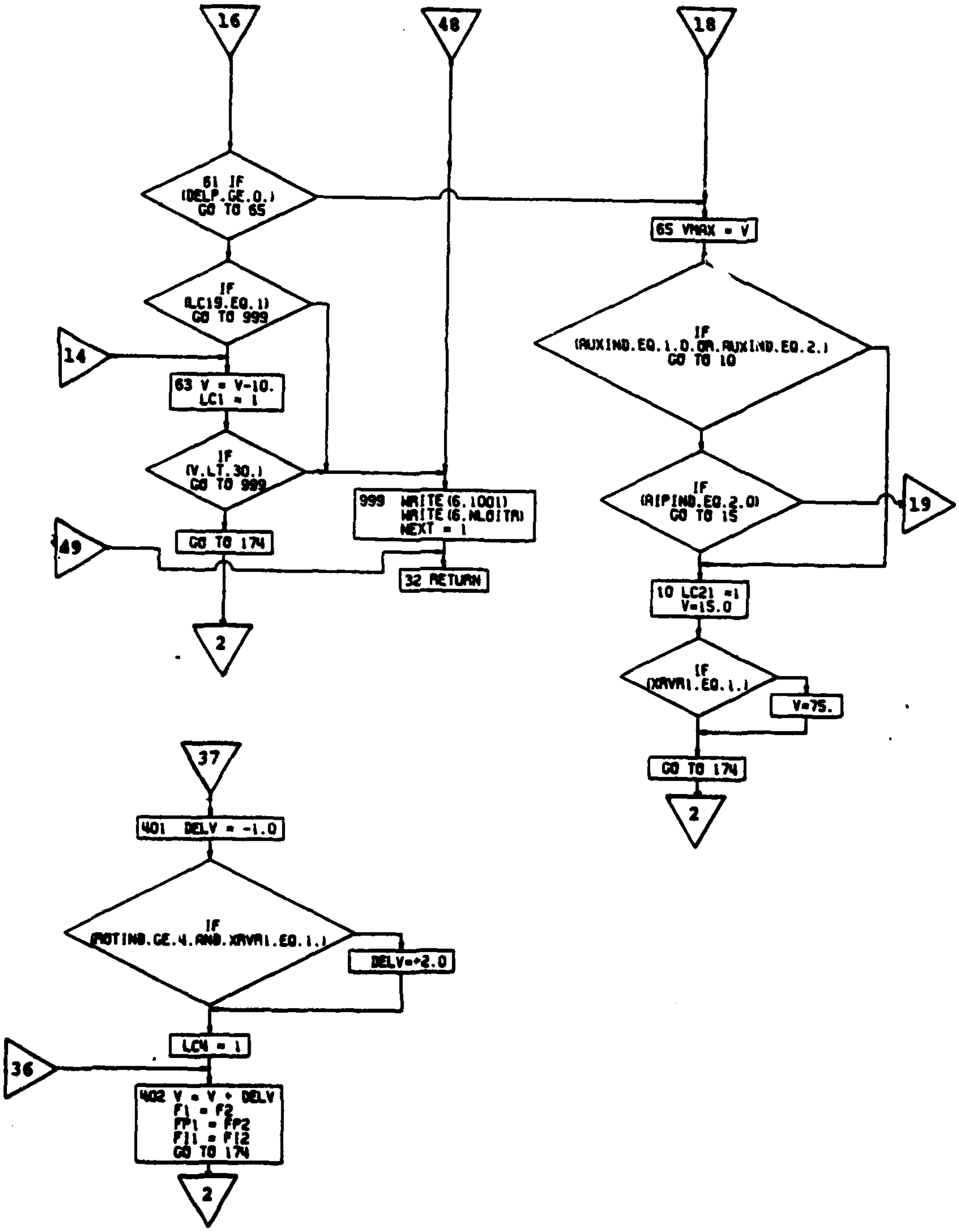


Figure 4-56. LOITR Subroutine, Flow Chart (Part 6 of 12)

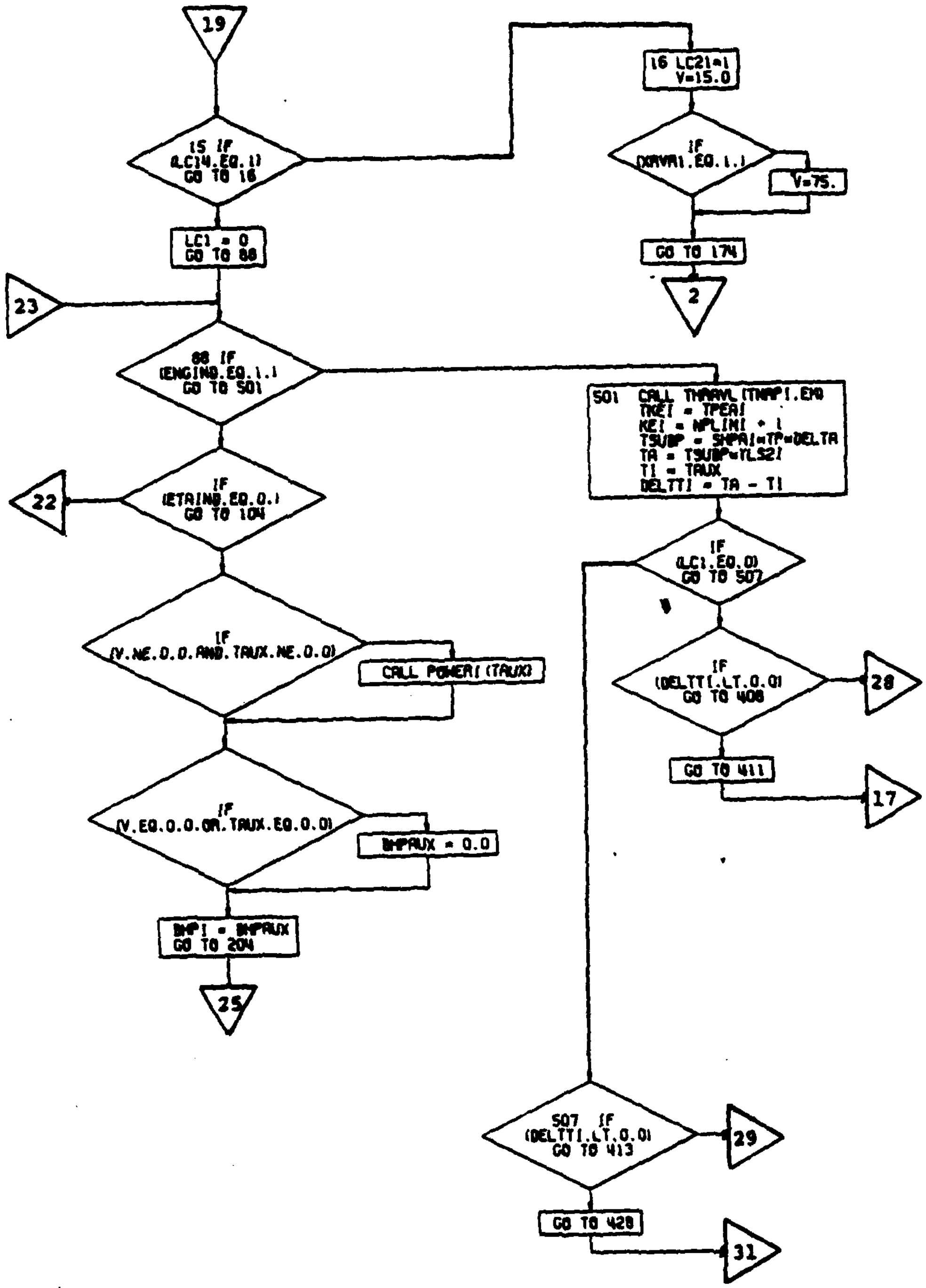


Figure 4-56. LOITR Subroutine, Flow Chart (Part 7 of 12)

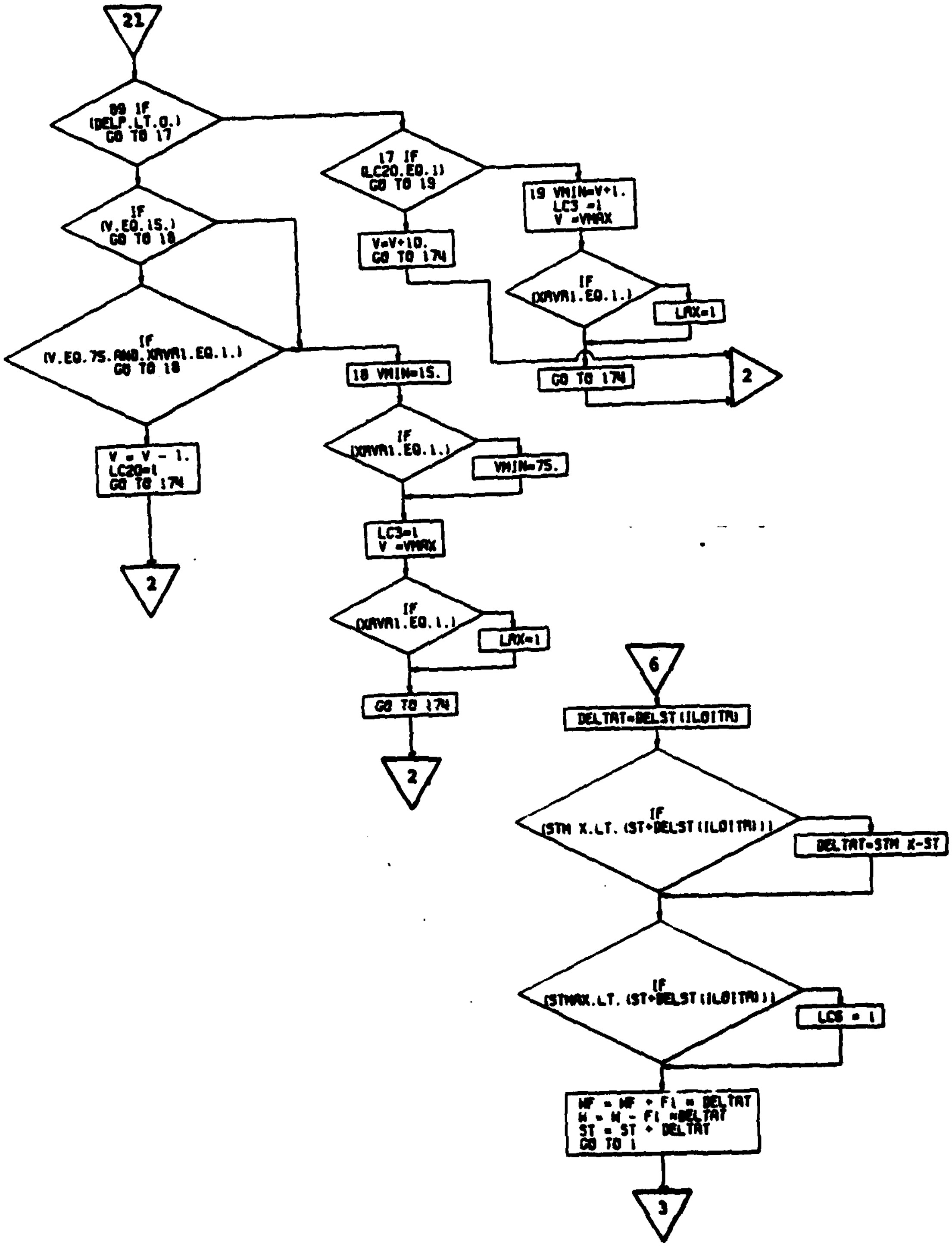


Figure 4-56. LOITR Subroutine, Flow Chart (Part 8 of 12)

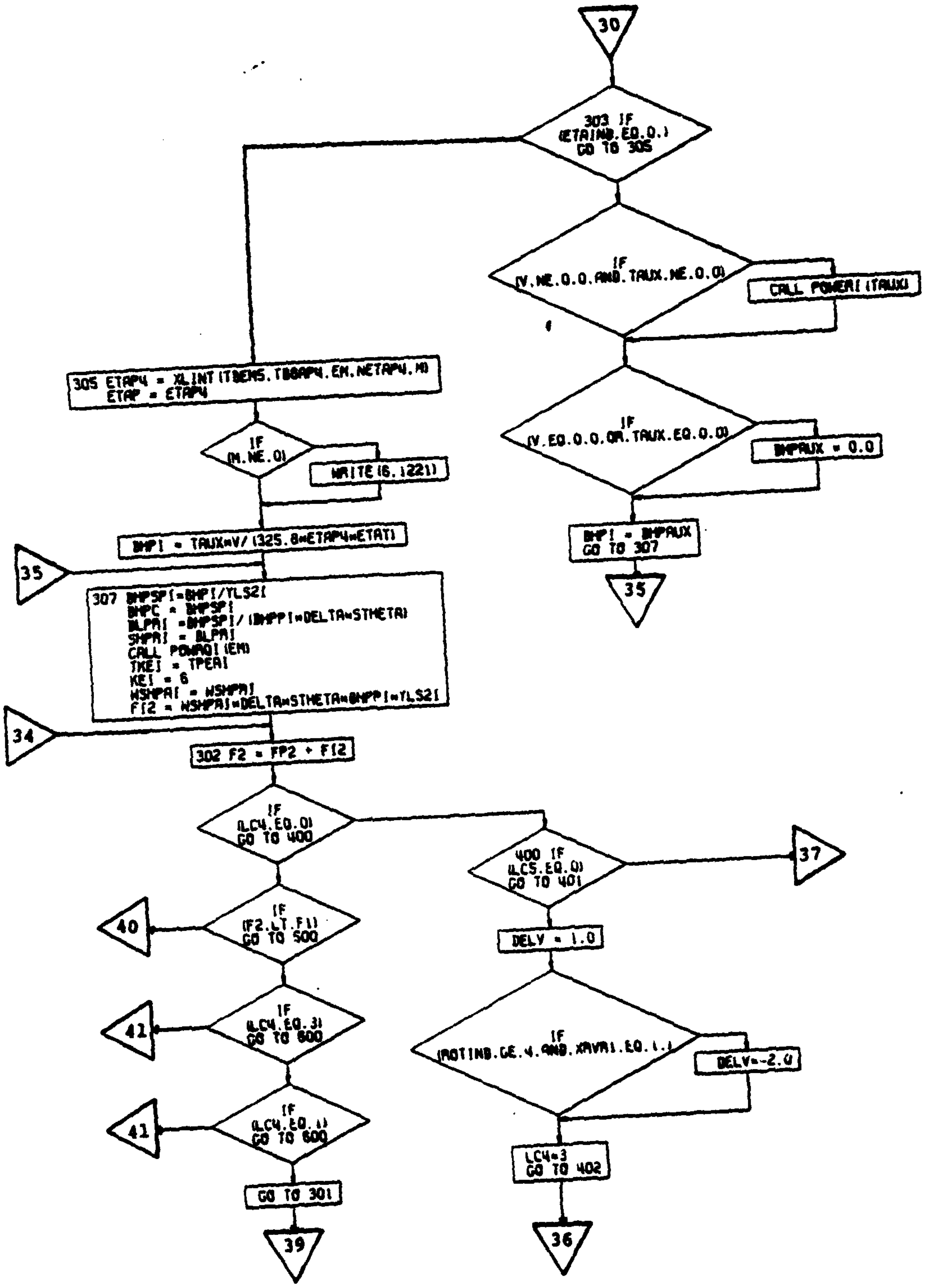


Figure 4-56. LOITR Subroutine, Flow Chart (Part 9 of 12)

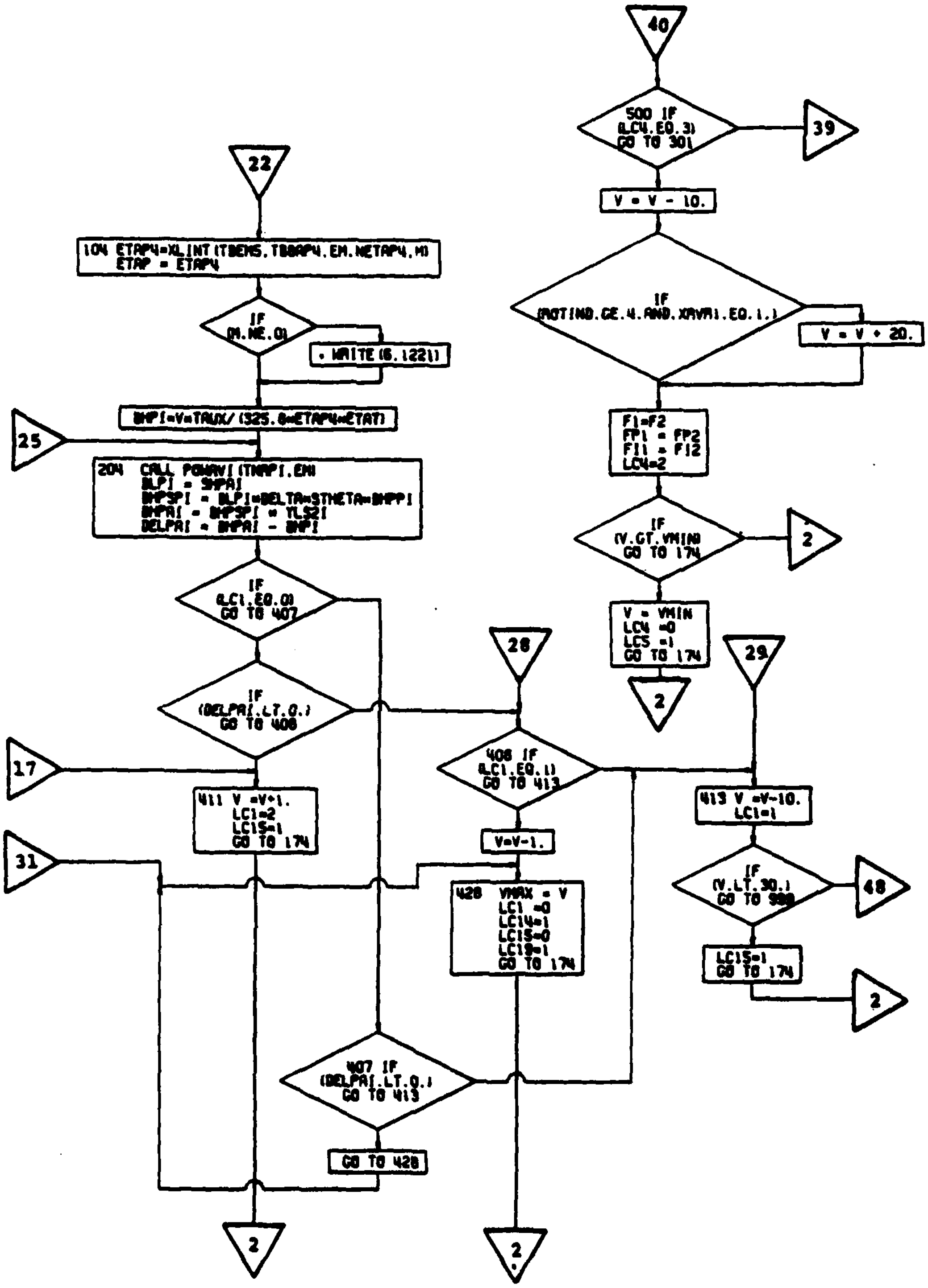


Figure 4-56. LOITR Subroutine, Flow Chart (Part 10 Of 12)

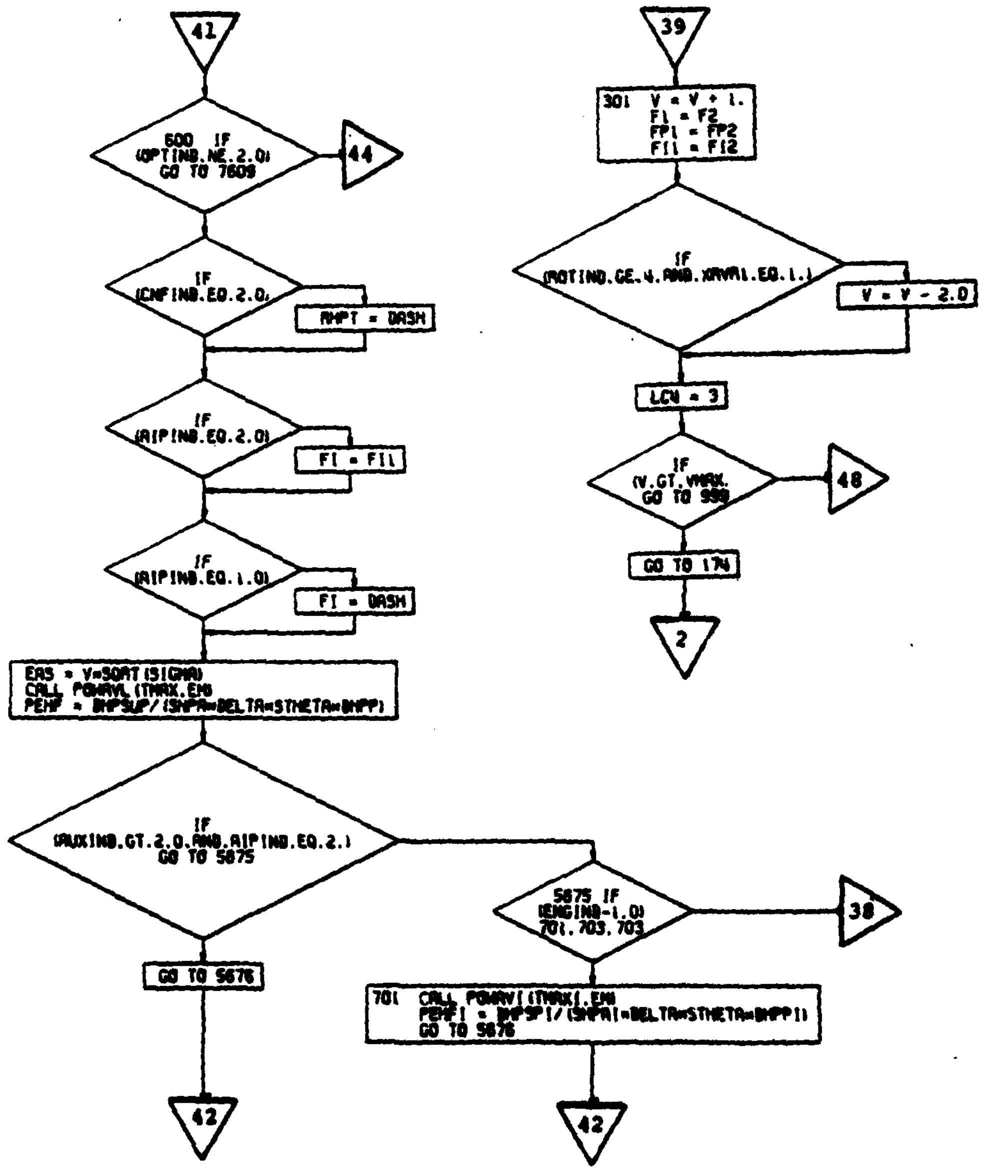


Figure 4-56. LOITR Subroutine, Flow Chart (Part 11 of 12)

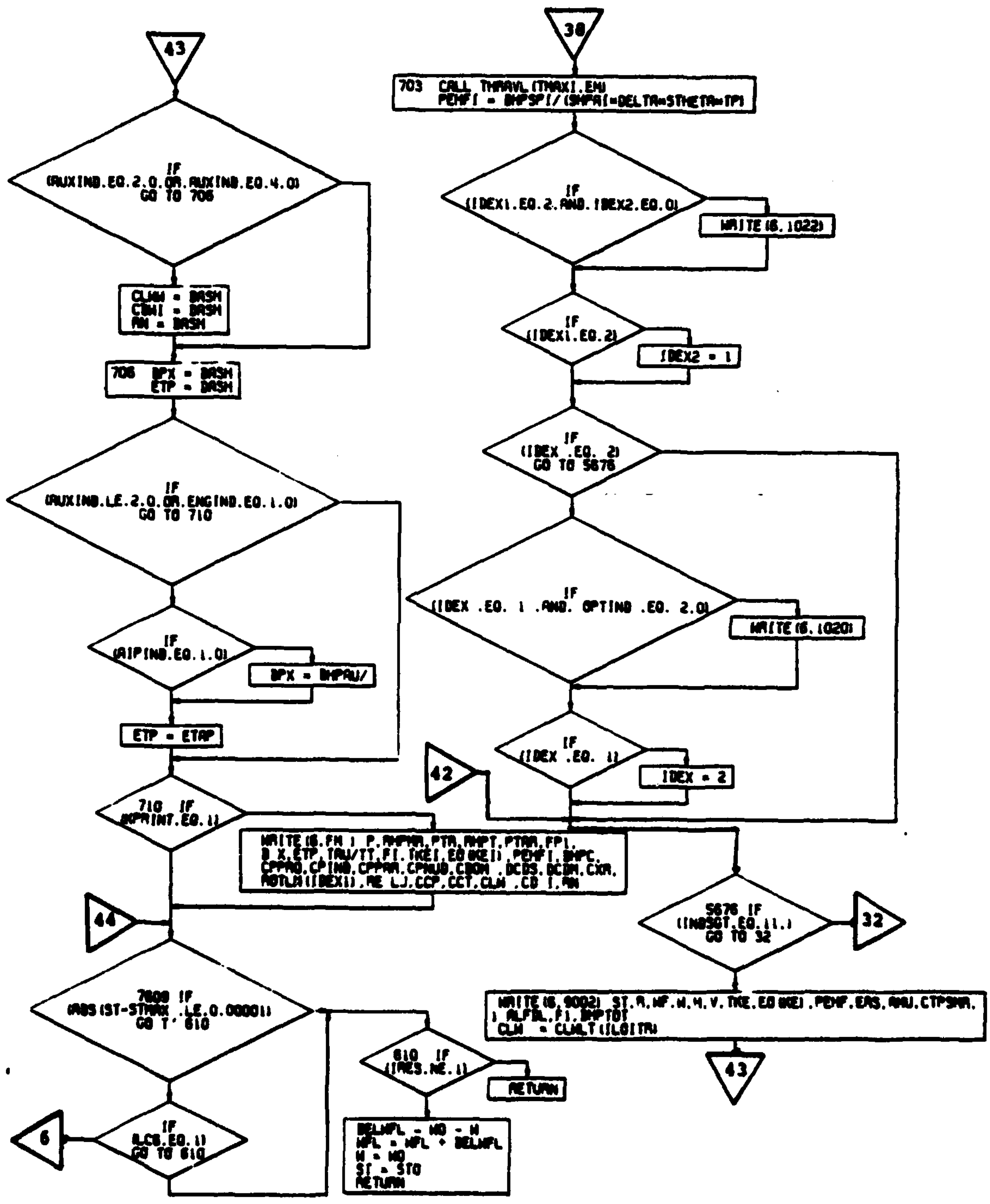


Figure 4-56. LOITR Subroutine, Flow Chart (Part 12 of 12)

4.12.7 Change of Weight Subroutines

The seventh and eighth performance segments represent an incremental change in weight of fuel or payload. These options would be used to simulate refueling, unloading or loading of passengers, or a fuel drop. The input to the subroutines consists of the increment in weight and a corresponding increment in time. The fuel or payload weight which is added is not allowed to increase the aircraft weight to a value greater than the gross weight unless a performance case is being run and WGTIND = 1. Inputting a large value for the increment in weight will bring the aircraft weight up to gross weight if WGTIND = 0 or a sizing case is being run. Figures 4-57 and 4-58 are flow charts of these subroutines.

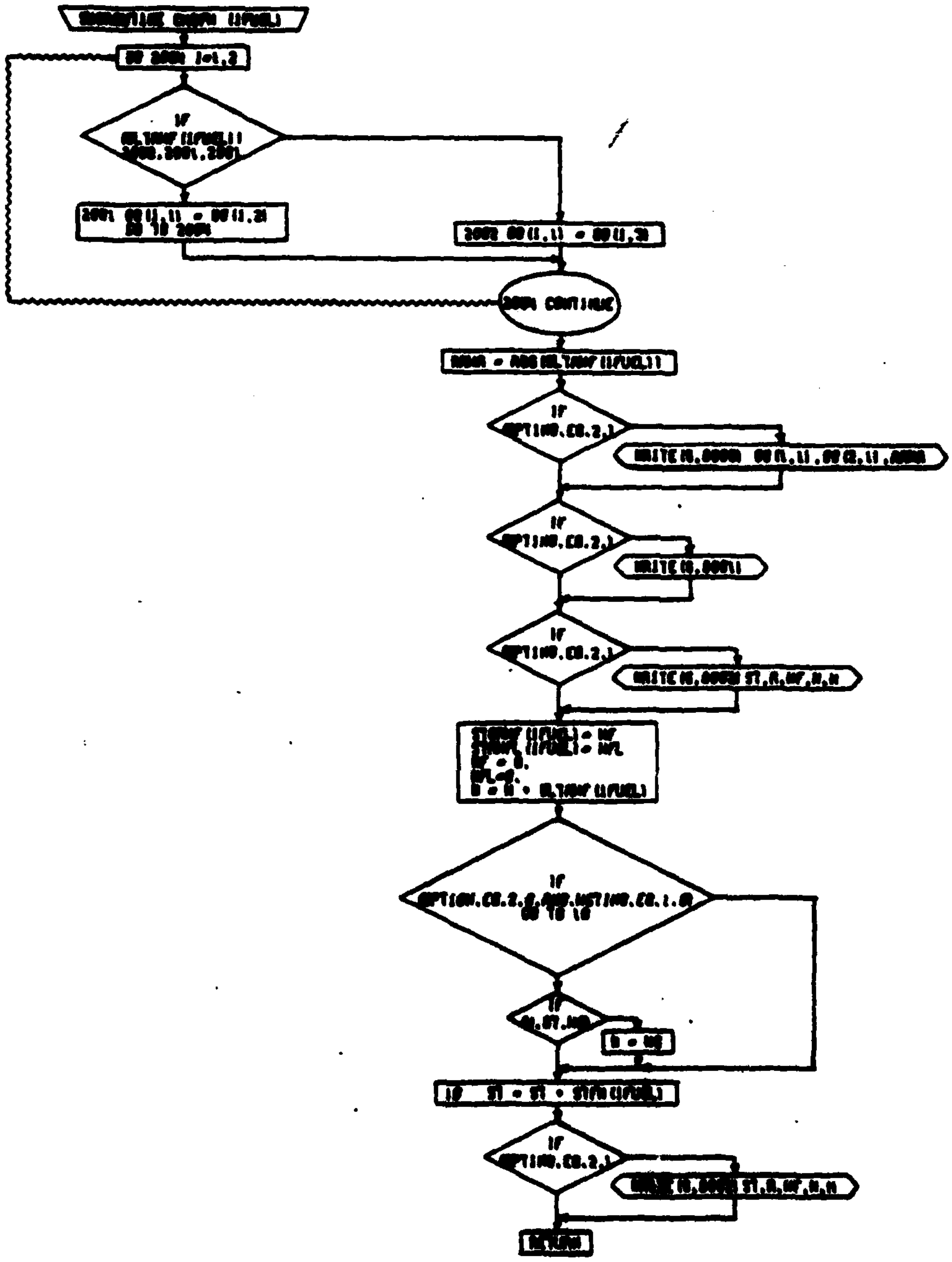


Figure 4-57. Change of Fuel Weight Subroutine, Flow Chart.

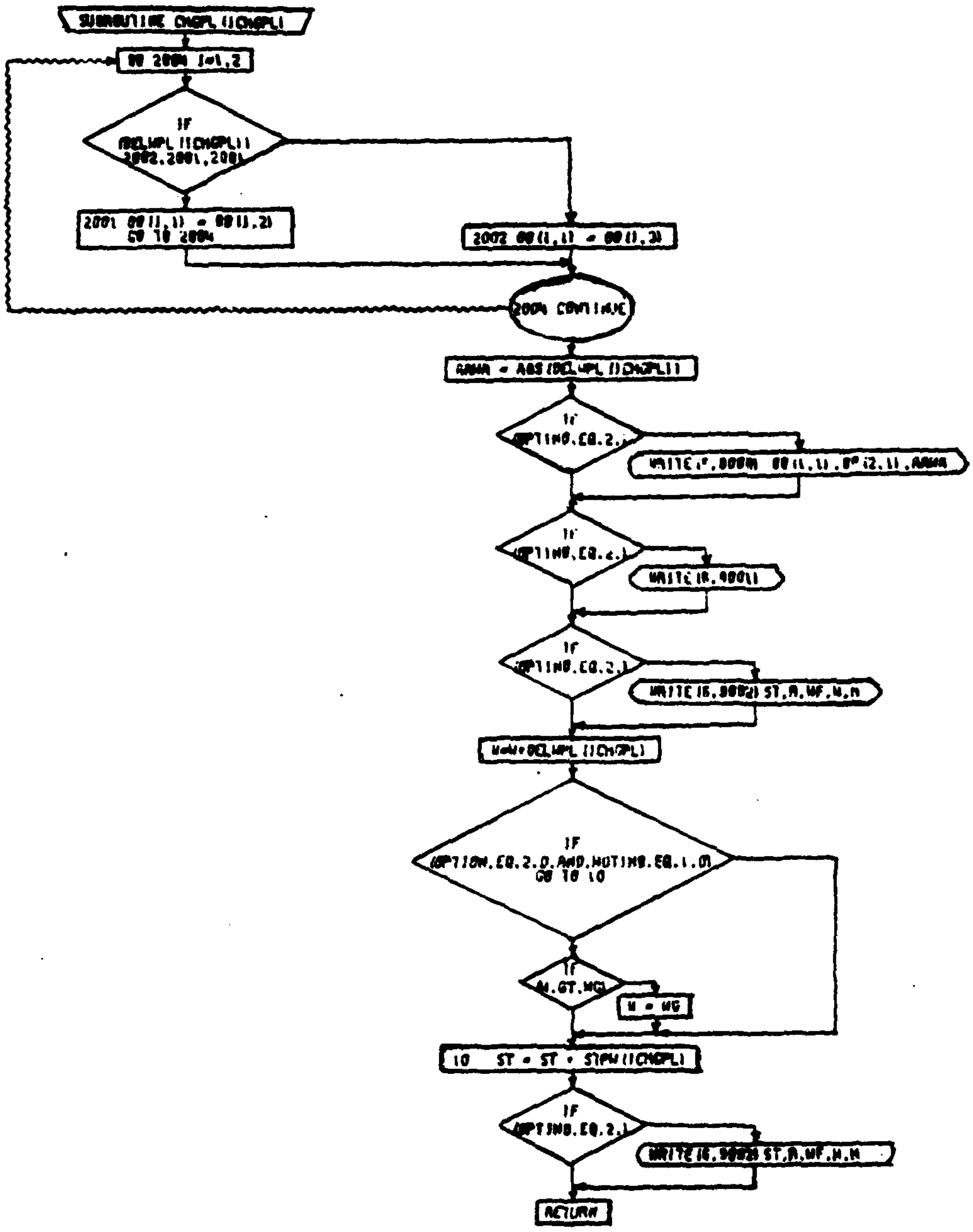


Figure 4-58. Change of Payload Weight Subroutine, Flow Chart.

4.12.8 Transfer Altitude

There are many different applications for which a discontinuous change in altitude may be desirable:

1. The flight profile may require takeoff at hot day, high altitude conditions followed by climb from sea level to specified altitude for standard day conditions.

2. It may be required that no credit be taken for range, fuel, or distance during descent (for example, Reference 9).

3. It may be required to study cruise speed at specified power at a series of different altitudes. This can be accomplished by a series of very short cruise segments interspersed with altitude transfers.

For these and other reasons, the program includes a transfer altitude segment, specified by SGTIND = 9. The only required input is the altitude to which the aircraft is to be transferred.

Transfer altitude may also be used during an optimum altitude search when it is followed by a cruise. In that case, the altitude which is input represents the maximum altitude permitted for the subsequent cruise.

Figure 4-59 is a flow chart of this subroutine.

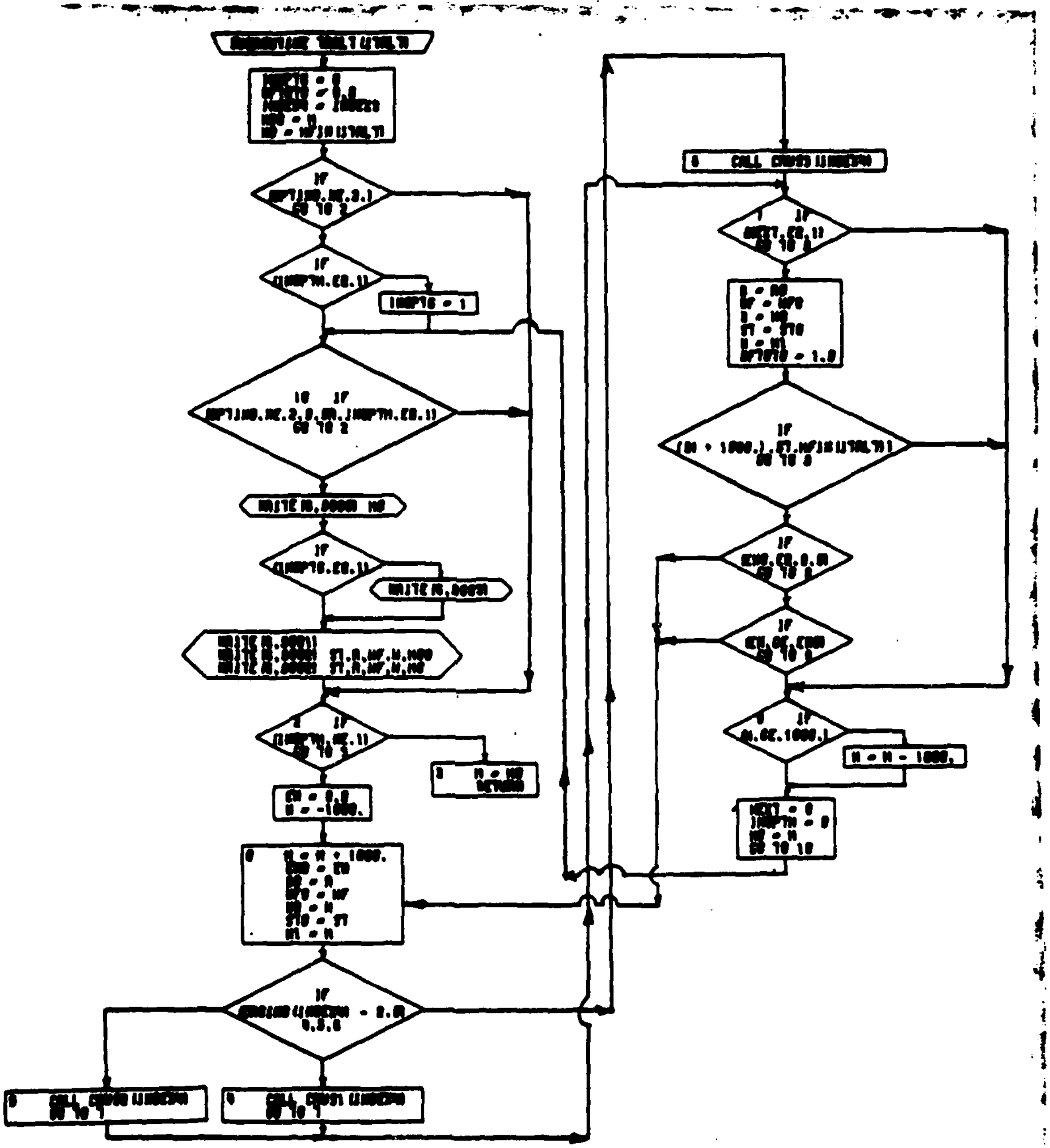


Figure 4-59. Transfer Altitude Subroutine, Flow Chart.

4.12.9 General Performance

SGTIND = 11   represents the calculation of aircraft general performance. The general performance calculation is based on gross weight or a change in gross weight as determined by the input indicator GWIND.

GWIND = 1. - User inputs the incremental change in gross weight into location 4150.

GWIND = 2. - User inputs the gross weight into location 4150.

The aircraft performance is calculated and printed out in velocity increments specified in LOC (4230) up to a maximum velocity input in LOC (4250). The program user specified the altitude, temperature, power turbine speed ratio, thrust to weight, wing lift coefficient, and incremental change in airplane equivalent flat plate area drag.

The general performance mission is usually input after an end of mission segment indicator, SGTIND = 0. A flow chart of the subroutine is shown in Figure 4-60.

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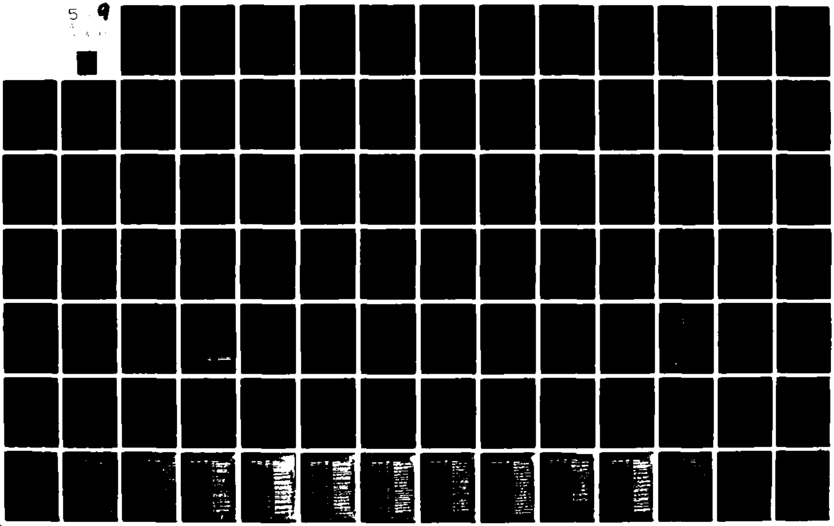

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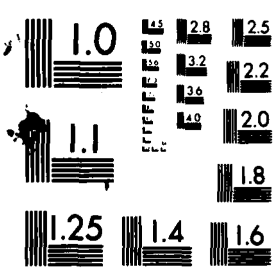

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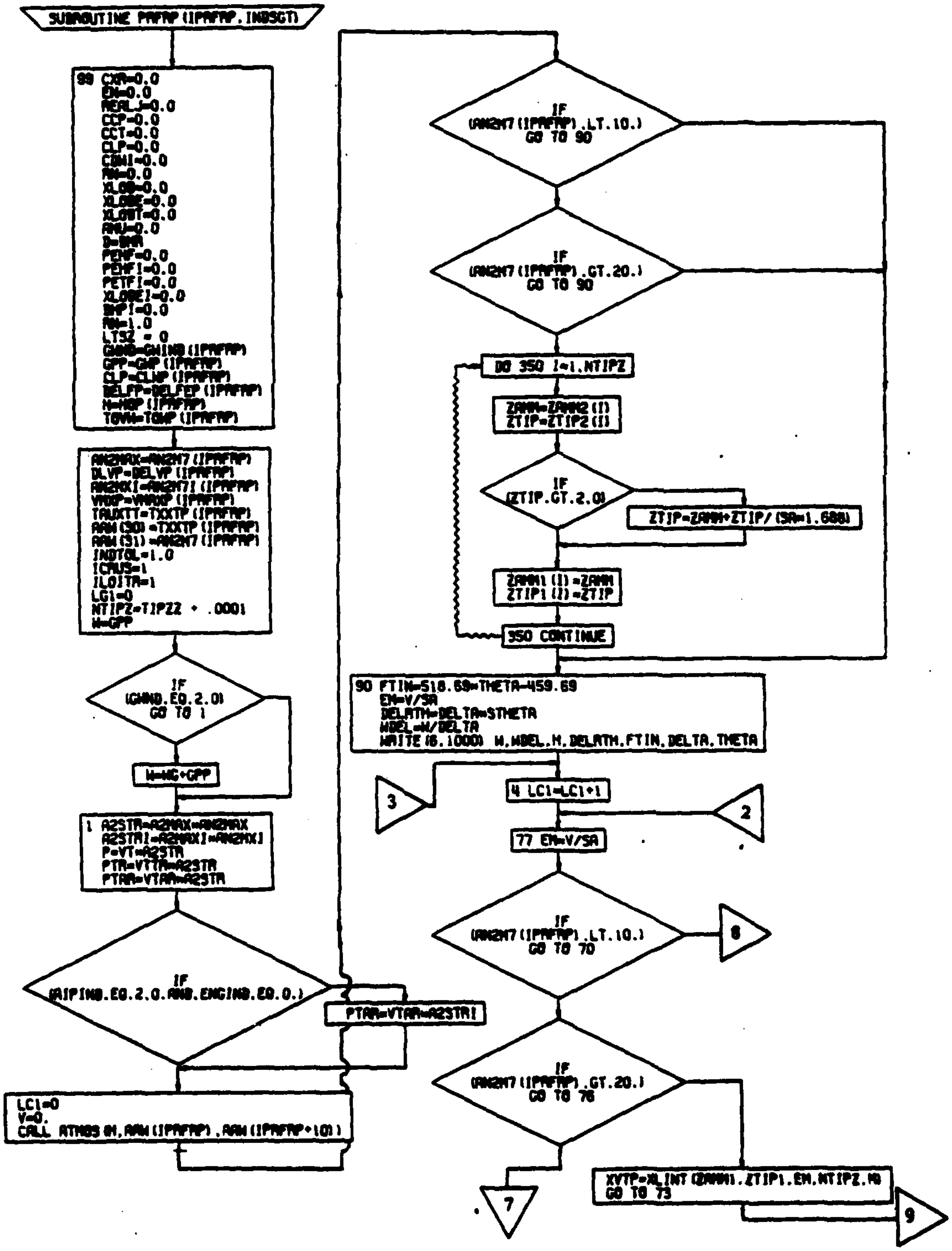

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 1 of 9)

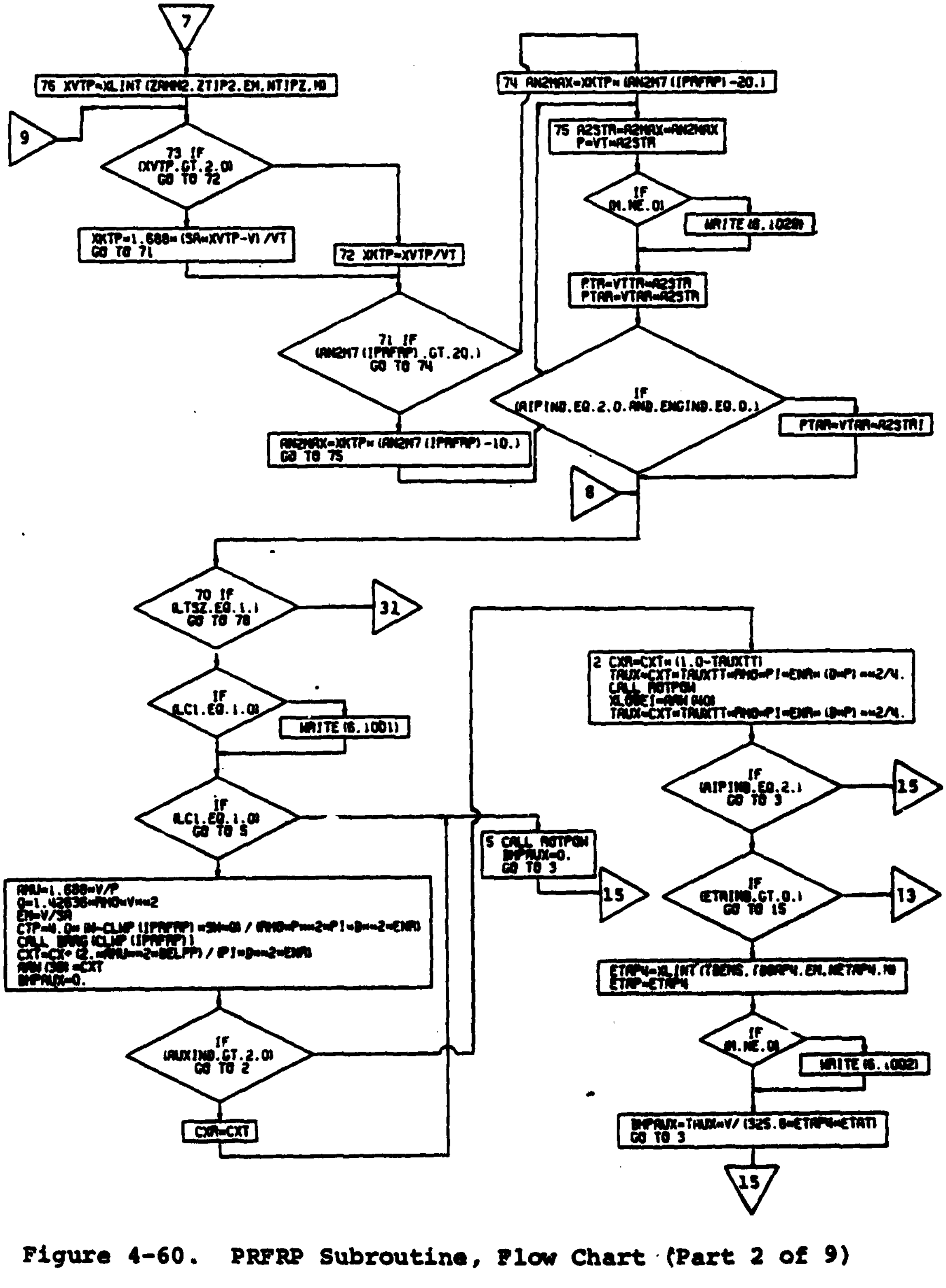

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 2 of 9)

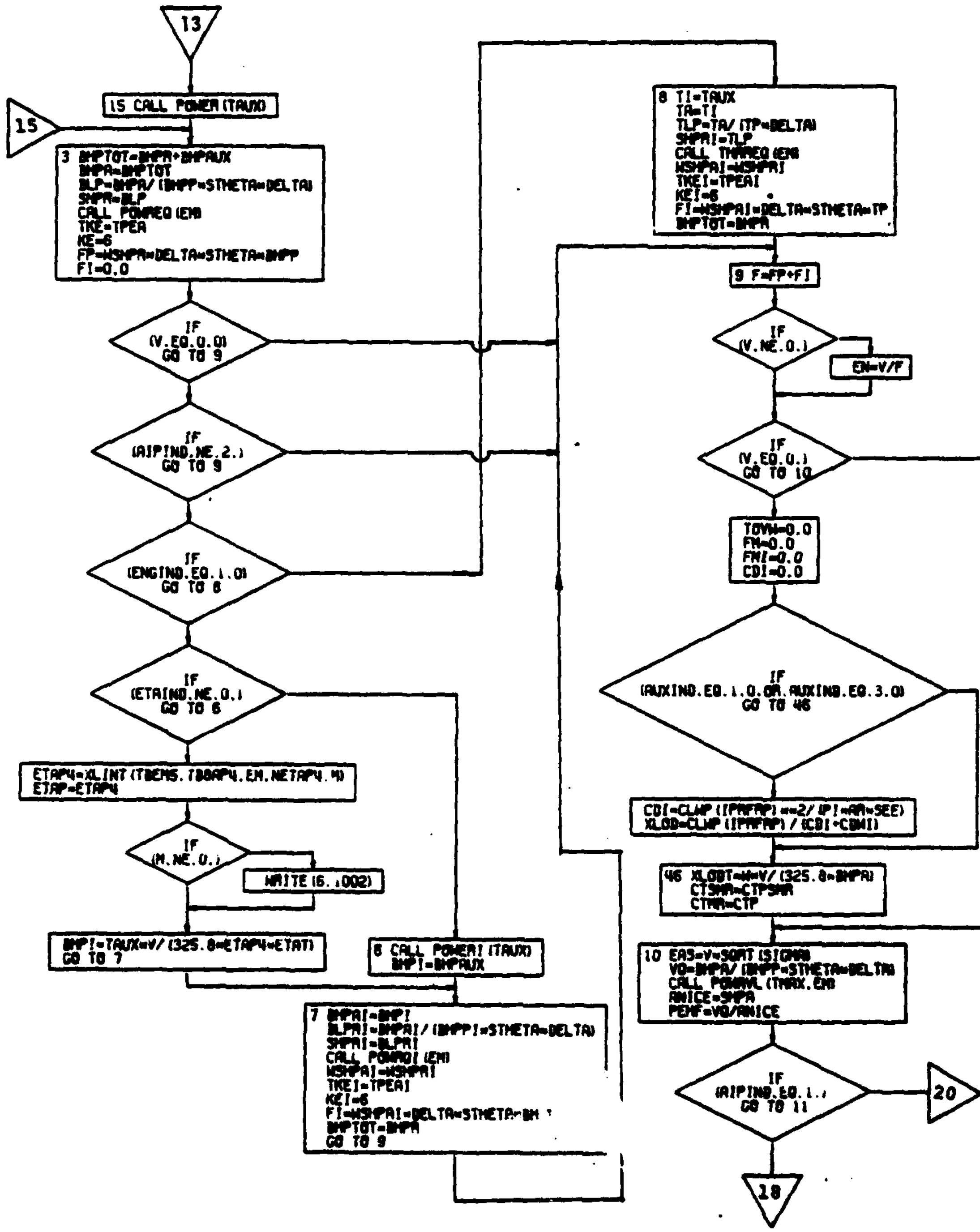

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 3 of 9)

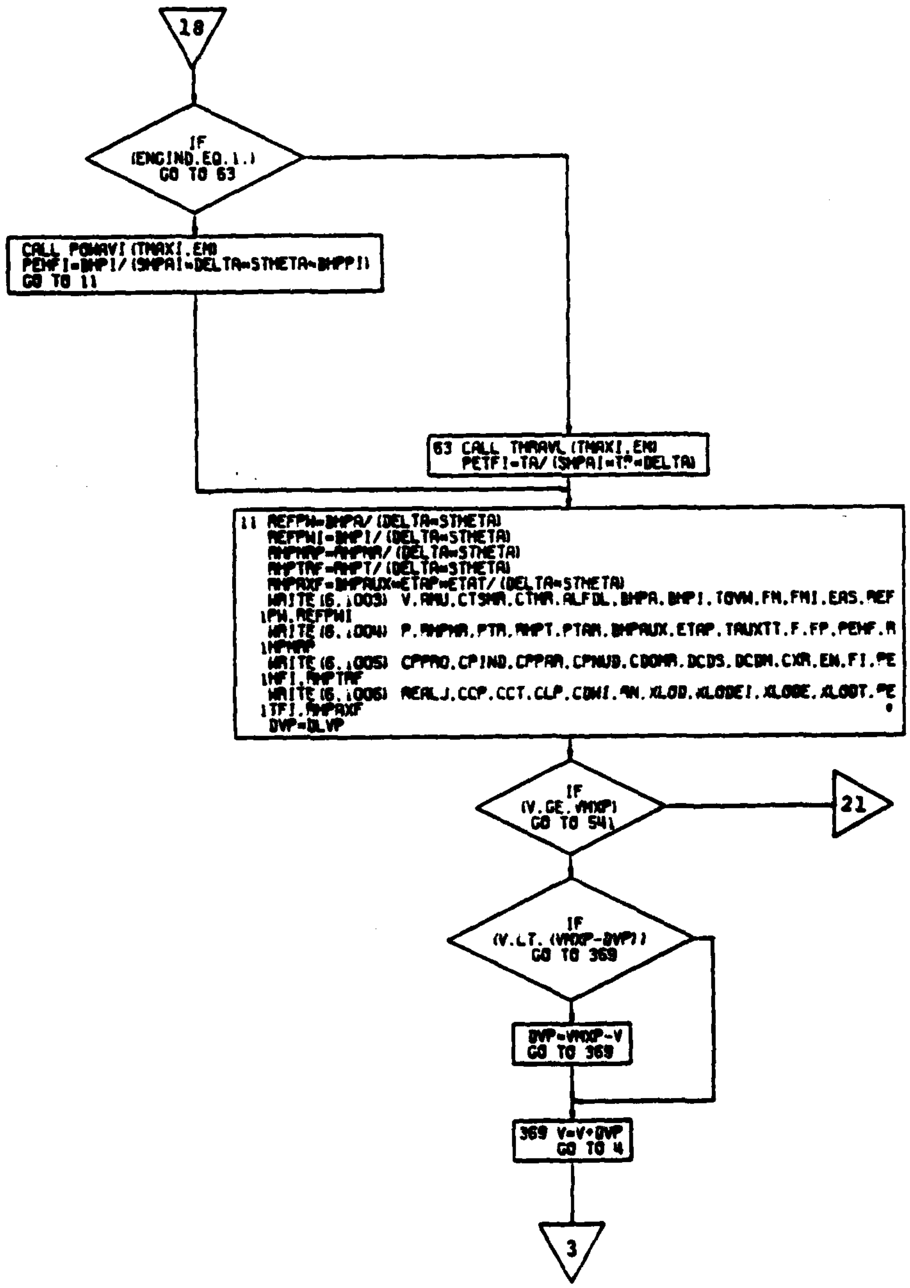

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 4 of 9)

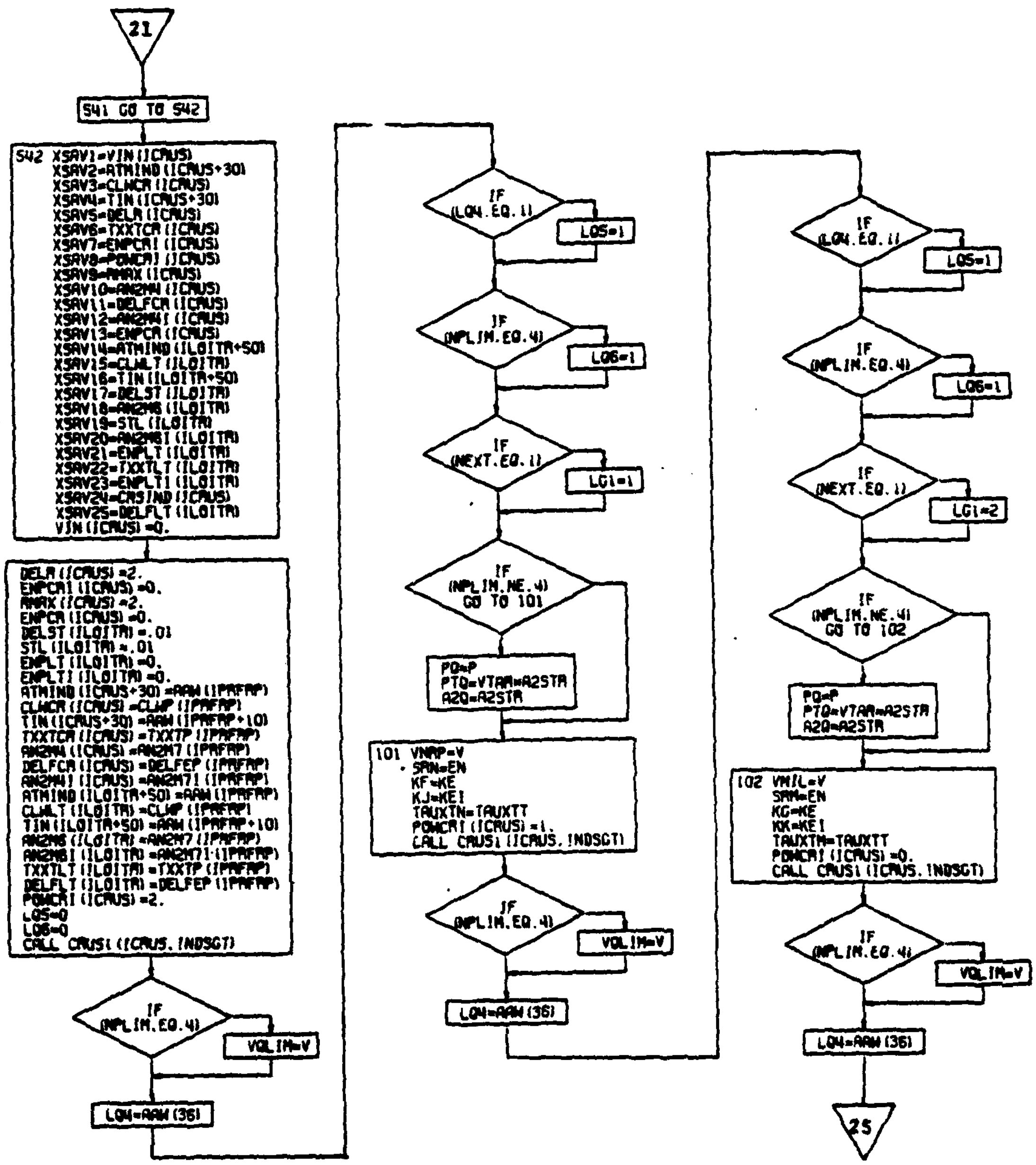

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 5 of 9)

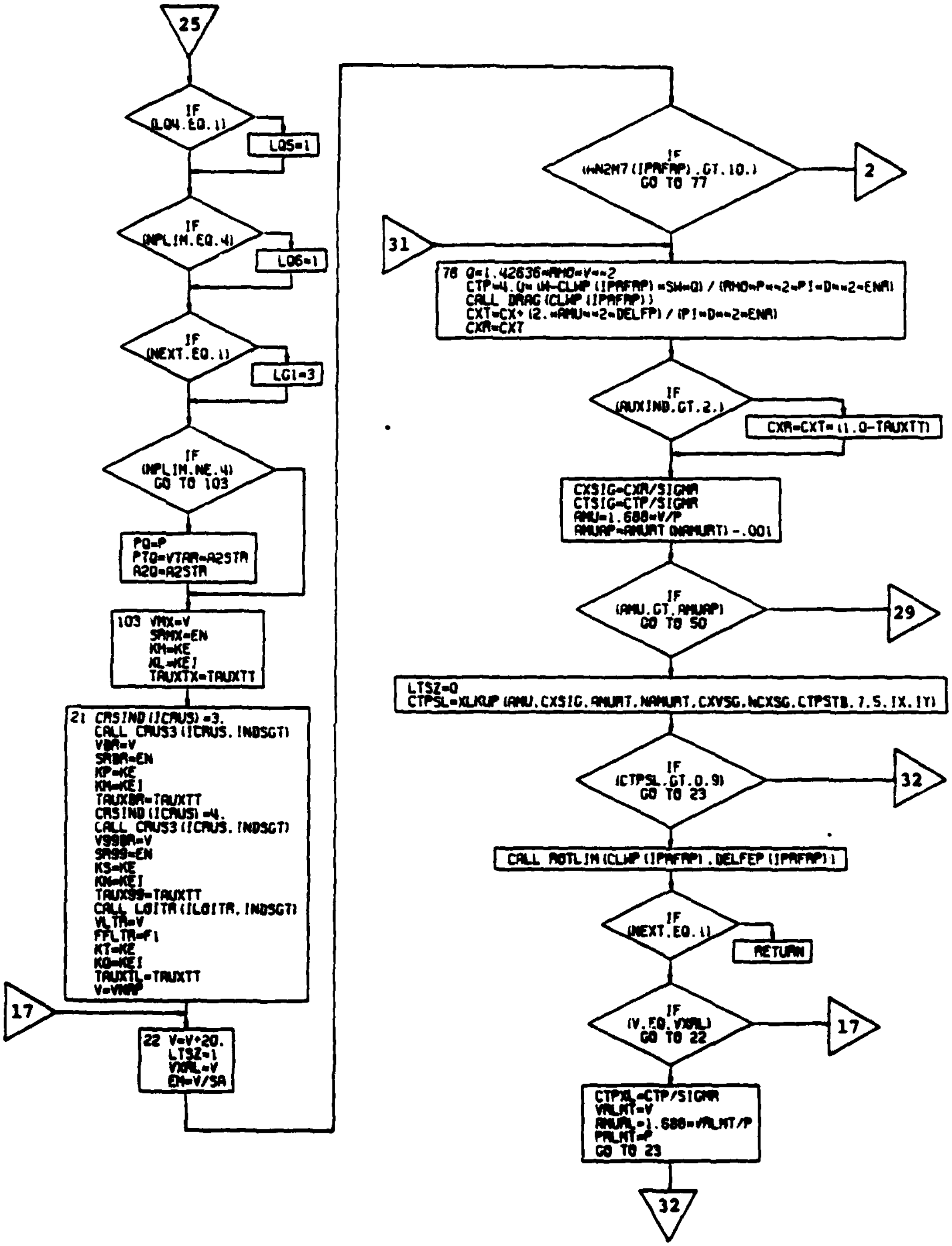

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 6 of 9)

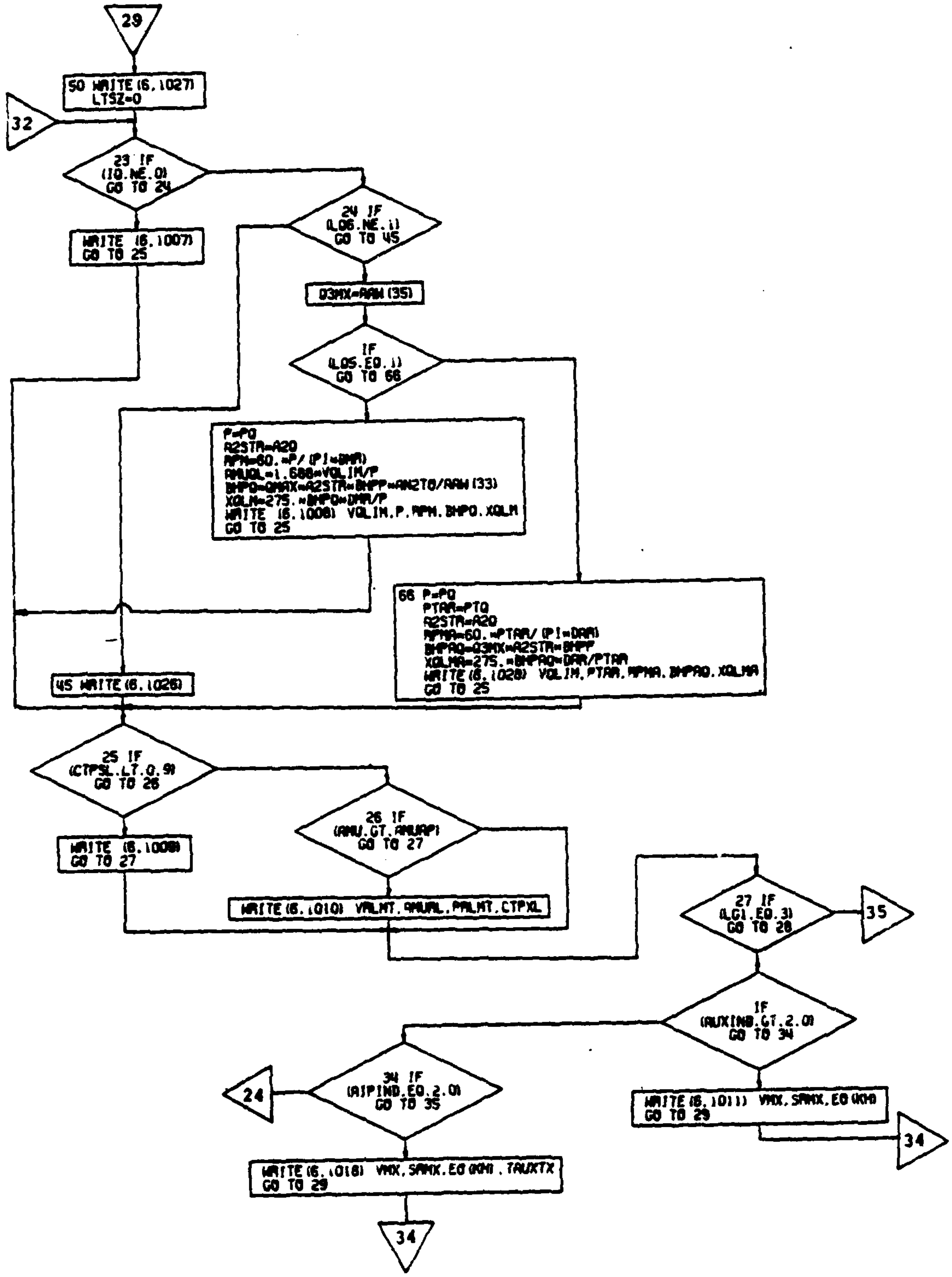

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 7 of 9)

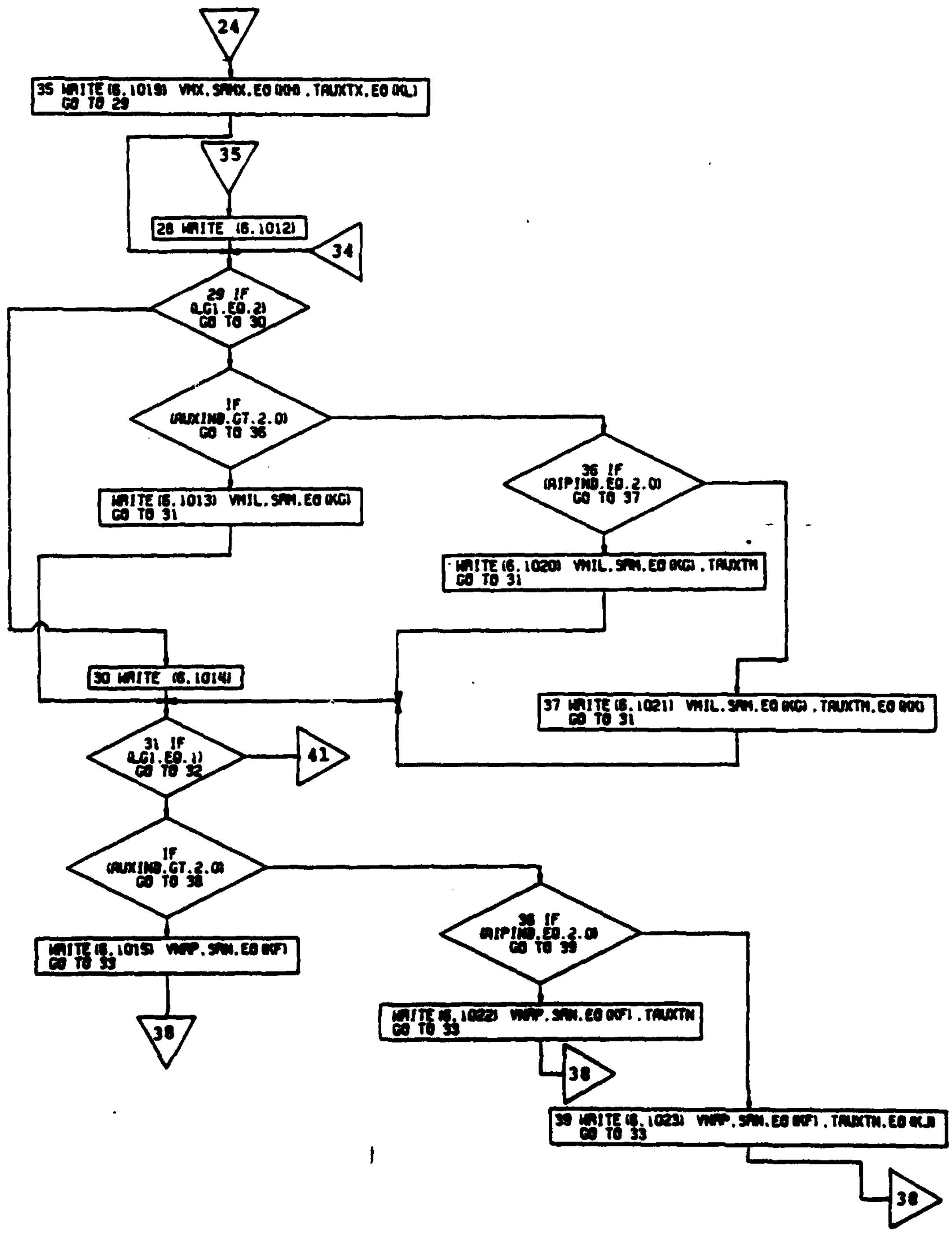

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 8 of 9)

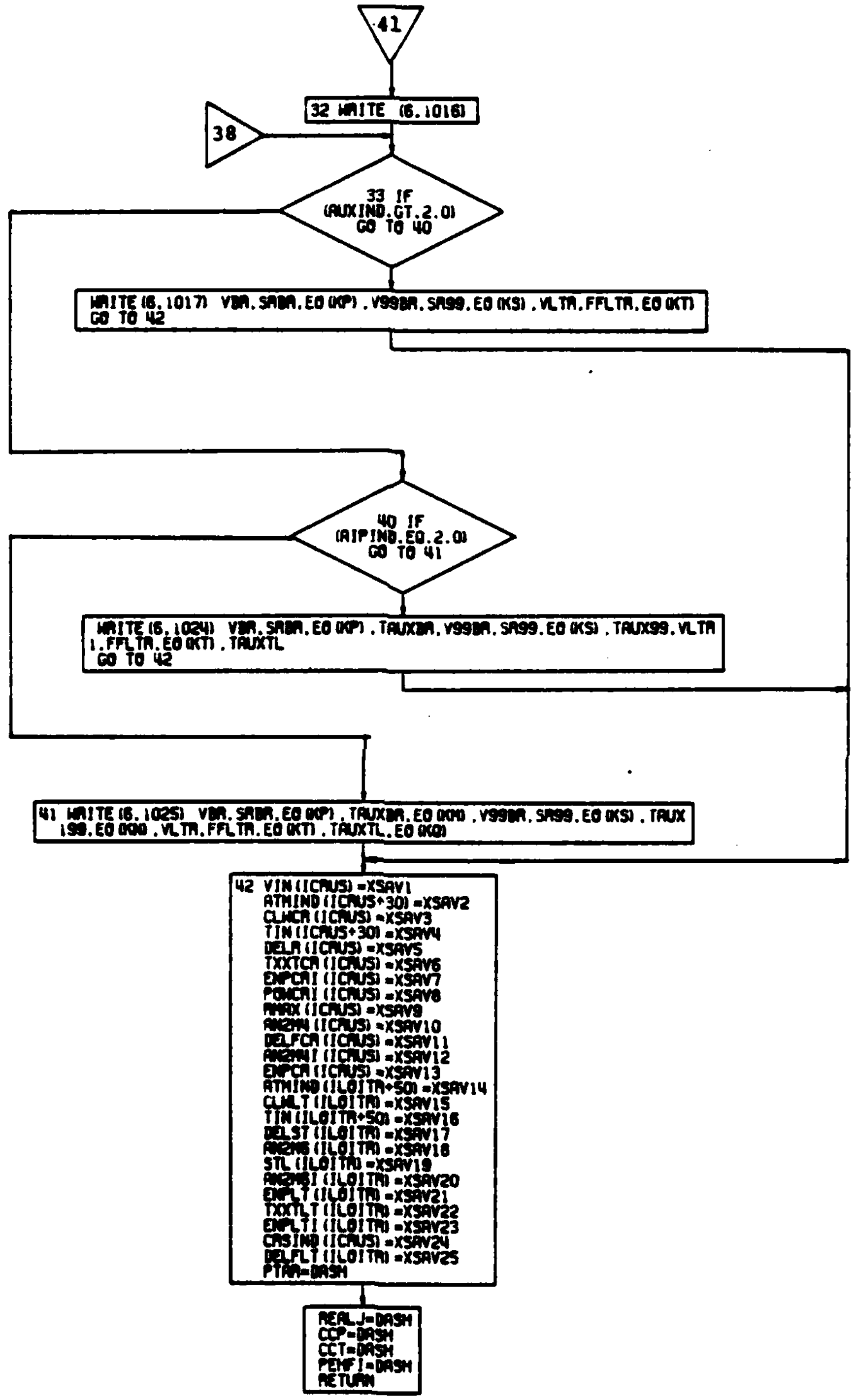

Figure 4-60. PRFRP Subroutine, Flow Chart (Part 9 of 9)

4.12.10 Function BIV

Function BIV is a two-dimensional Bivarian table look-up used to interpret values such as referred thrust or horsepower, referred fuel flow, and referred N_I and N_{II}. The BIV function performs a linear interpolation between two points on the ordinate and two points on the abscissa. A flow chart of the subroutine is shown in Figure 4-61.

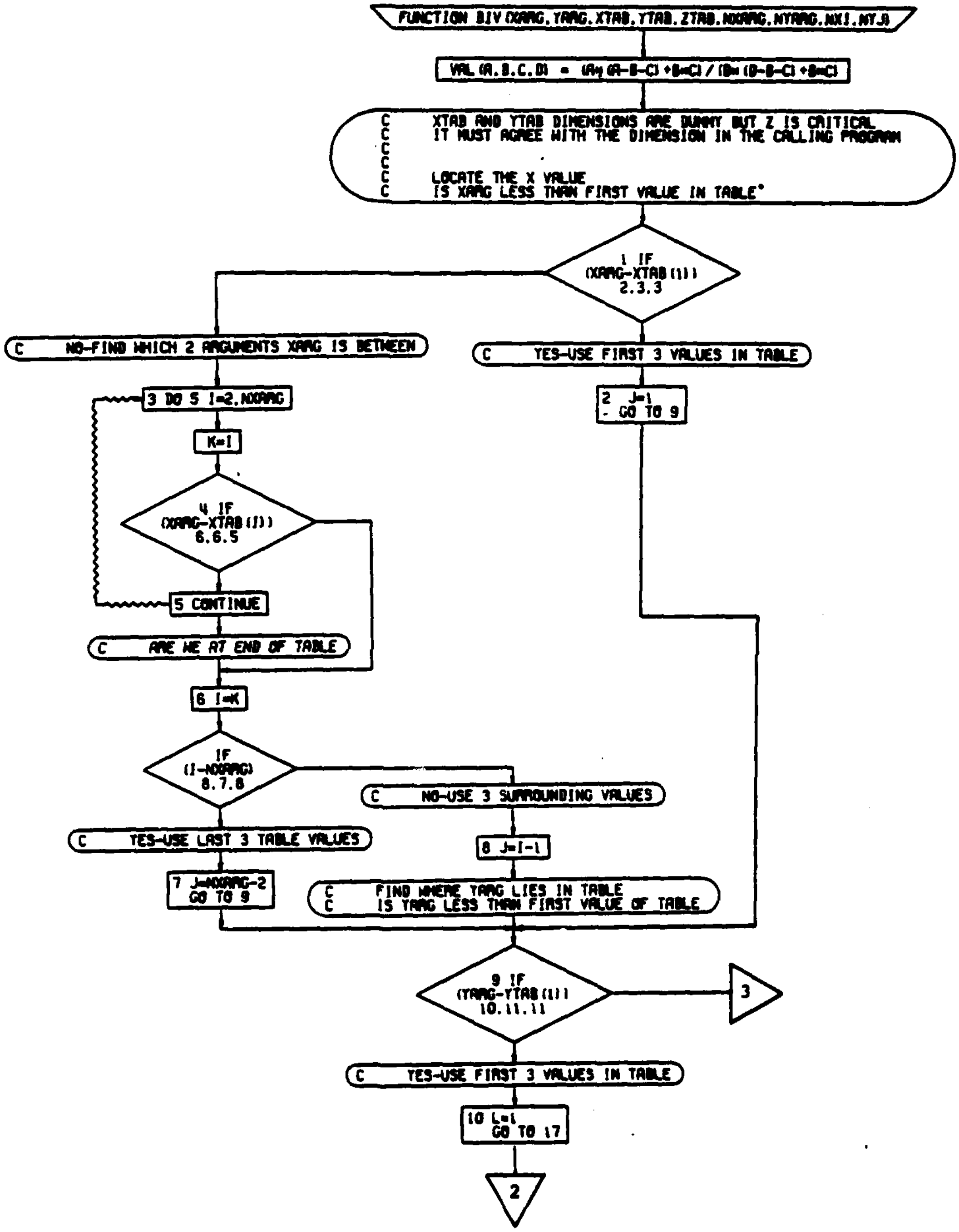

Figure 4-61. BIV Function, Flow Chart (Part 1 of 2)

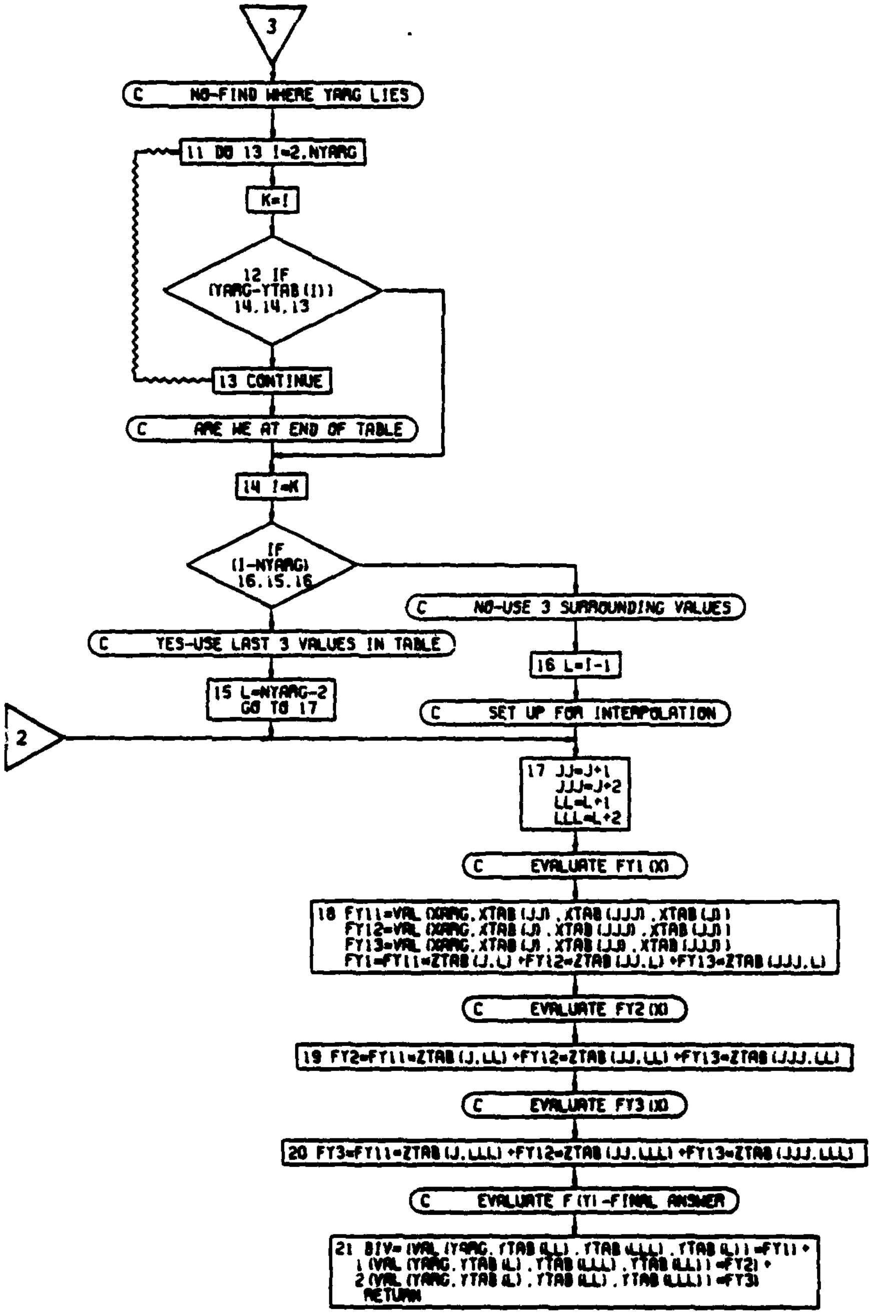

Figure 4-61. BIV Function, Flow Chart (Part 2 of 2)

4.12.11 <u>Function PARA</u>

PARA is a two-dimensional parabolic interpretation function used periodically throughout HESCOMP. A flow chart of the subroutine is shown in Figure 4-62.

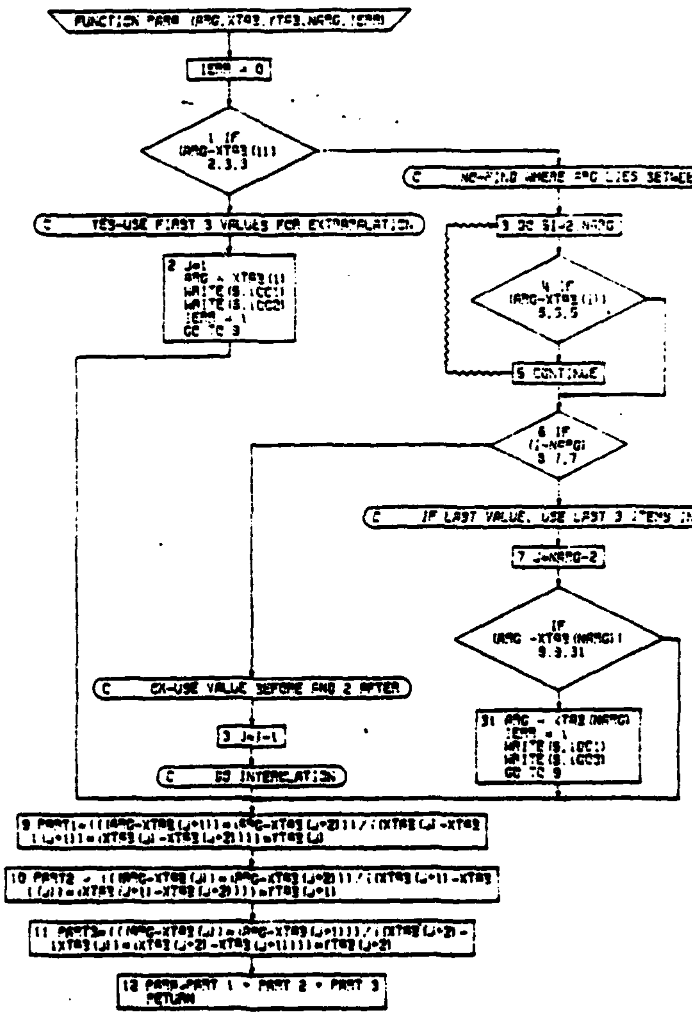

Figure 4-62. PARA Function, Flow Chart

4.12.12 <u>Function Table</u>

TABLE is a fourth-order Lagrangian interpolation function shown flowcharted in Figure 4-63.

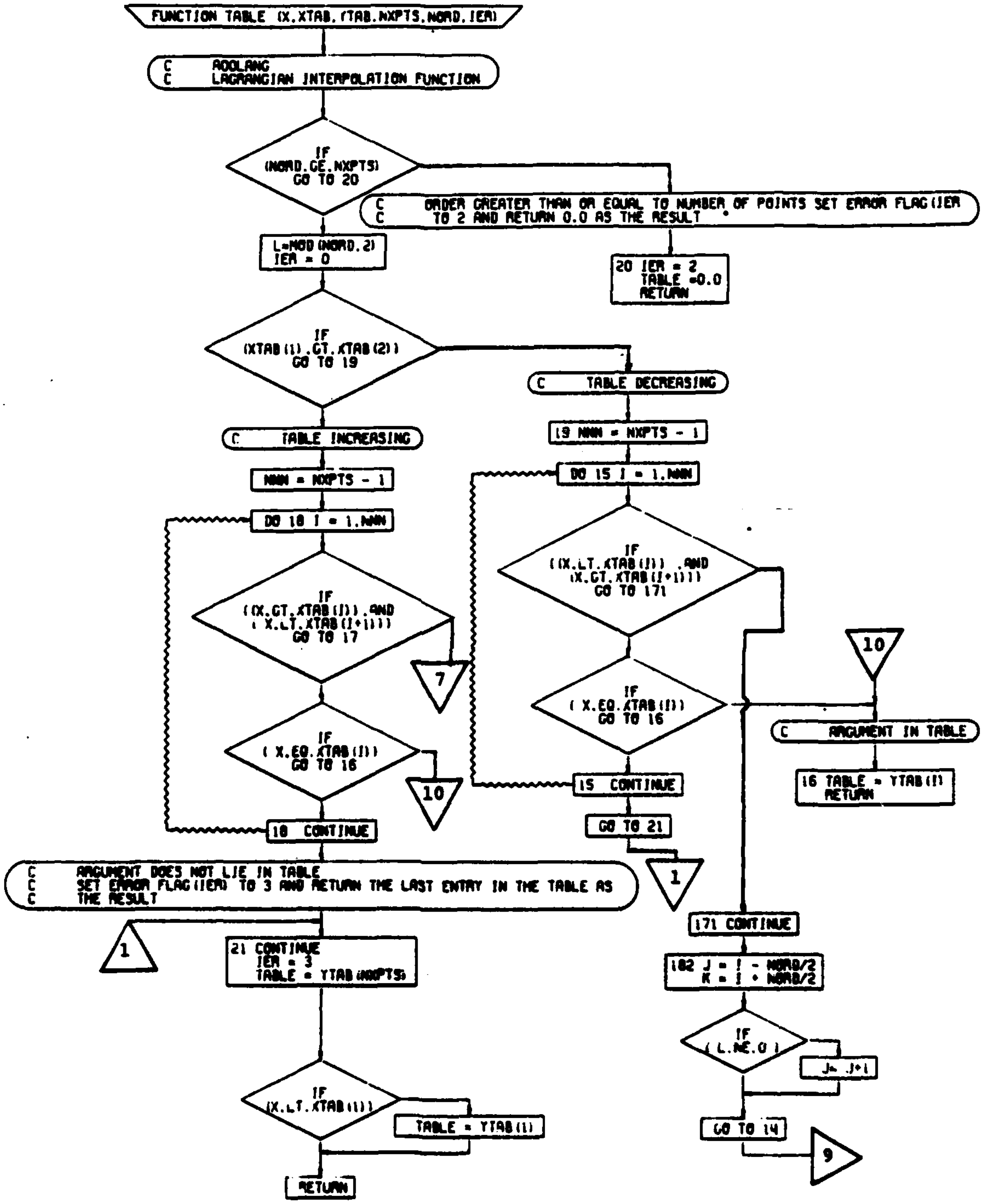

Figure 4-63. TABLE Function, Flow Chart (Part 1 of 2)

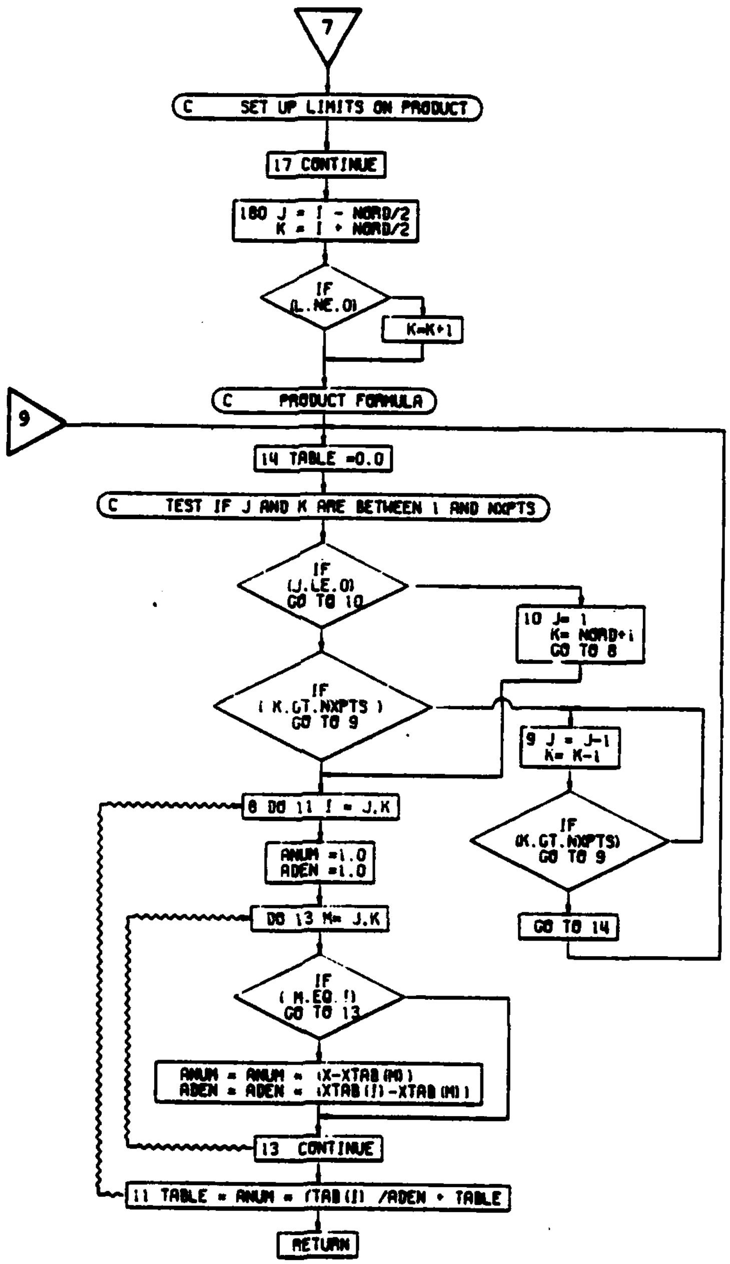

Figure 4-63. TABLE Function, Flow Chart (Part 2 of 2)

4.12.13 Function TRIV

TRIV is a three-dimensional parabolic table look-up function. The subroutine flow chart is shown in Figure 4-64.

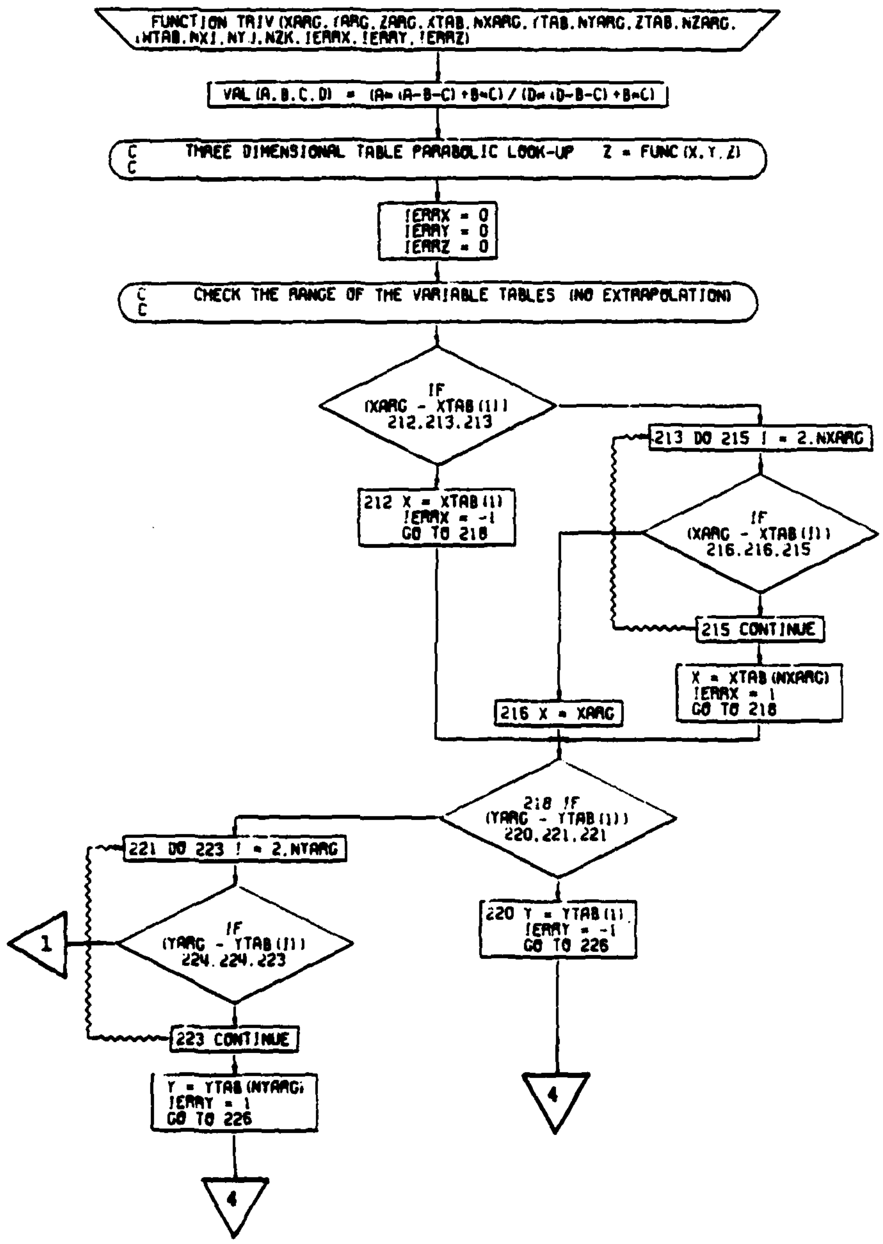

Figure 4-64. TRIV Function, Flow Chart (Part 1 of 5)

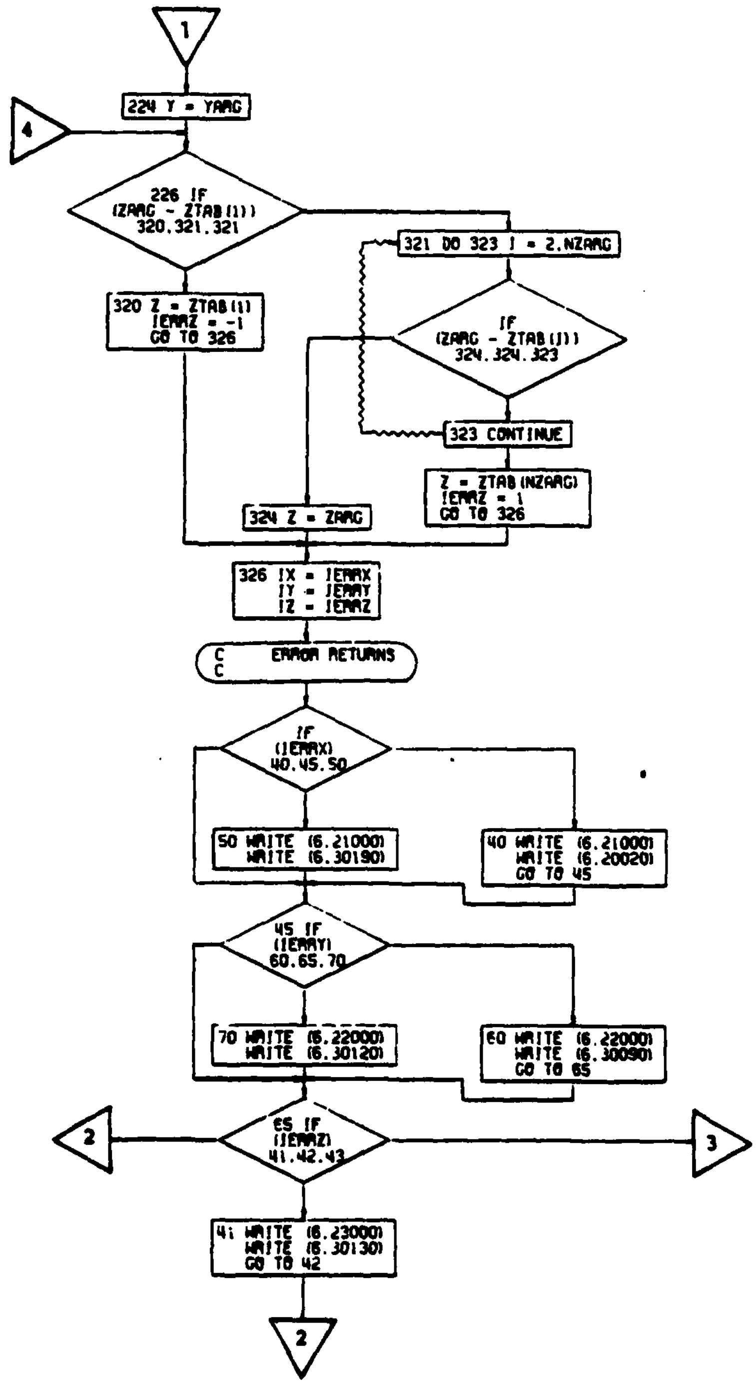

Figure 4-64. TRIV Function, Flow Chart (Part 2 of 5)

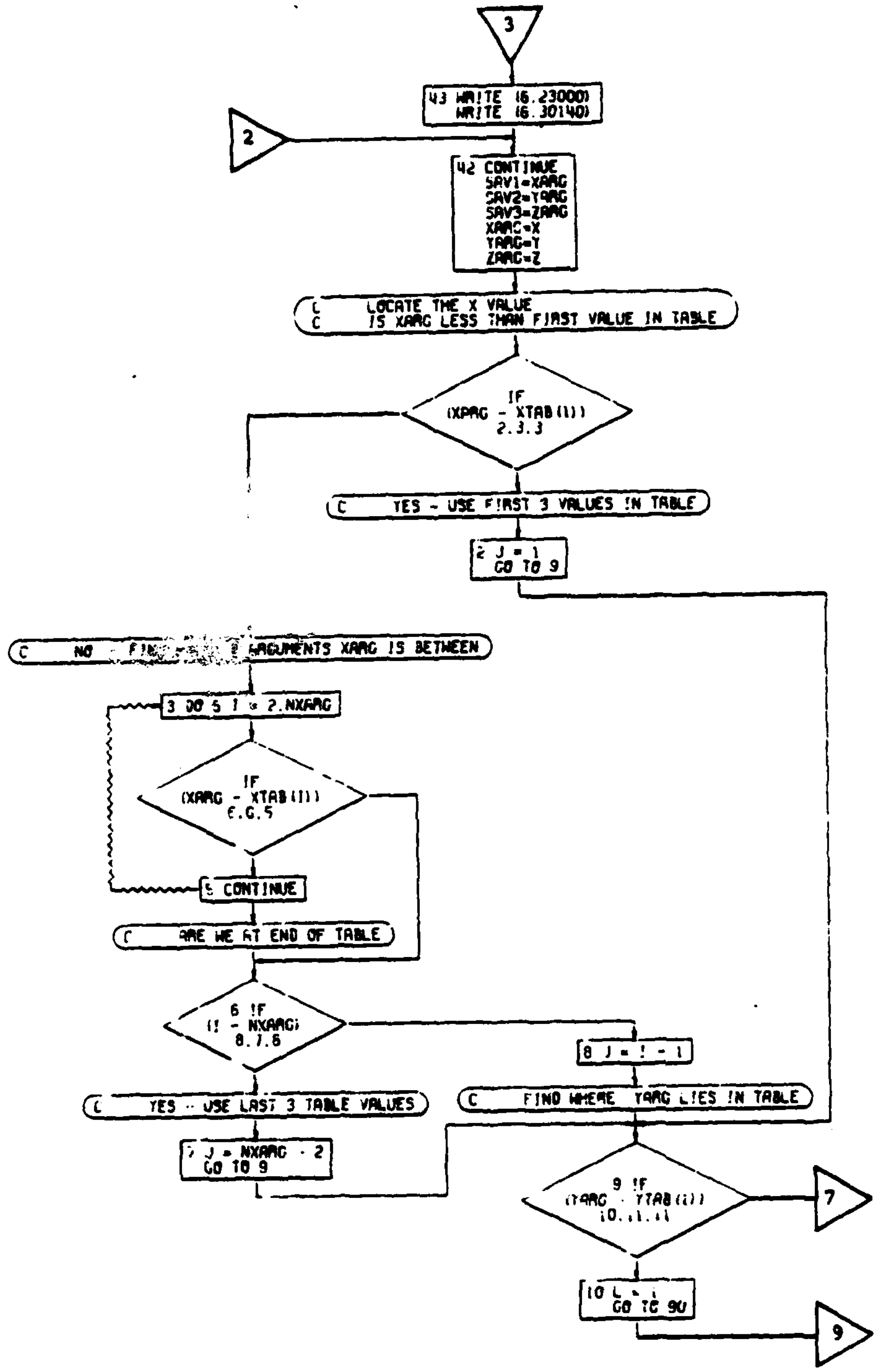

Figure 4-64. TRIV Function, Flow Chart (Part 3 of 5)

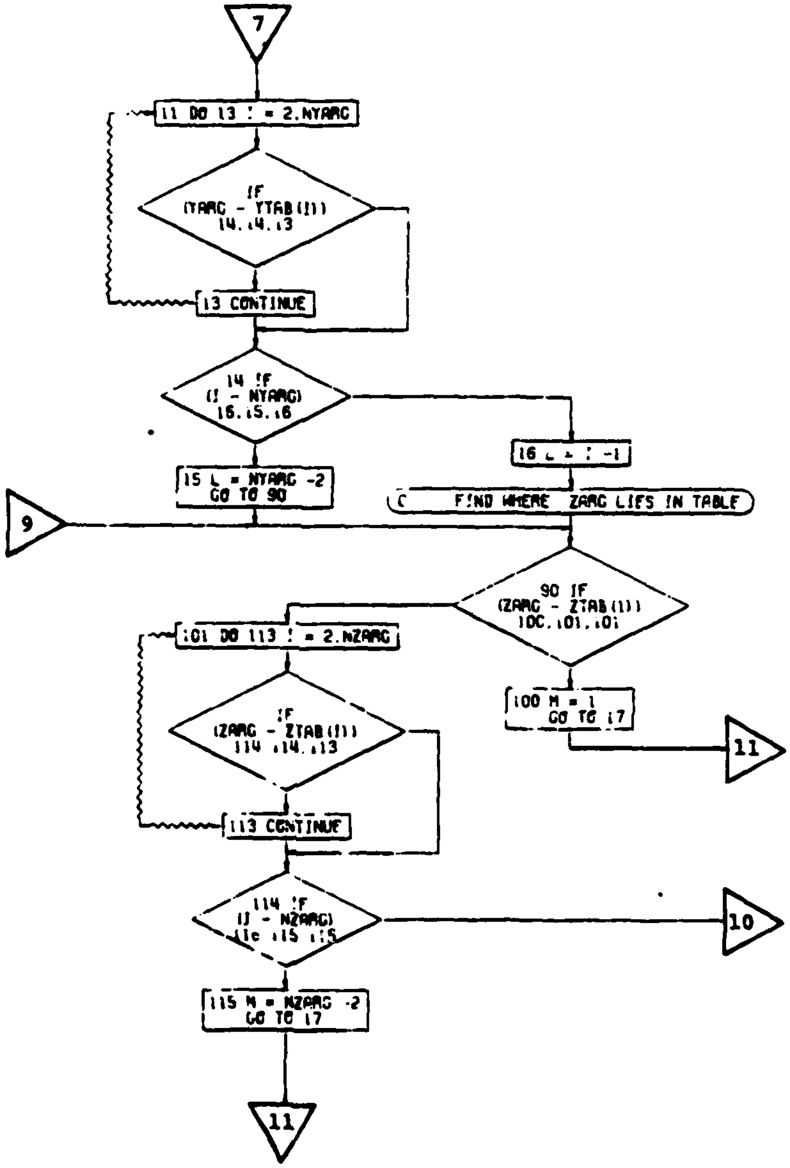

Figure 4-64. TRIV Function, Flow Chart (Part 4 of 5)

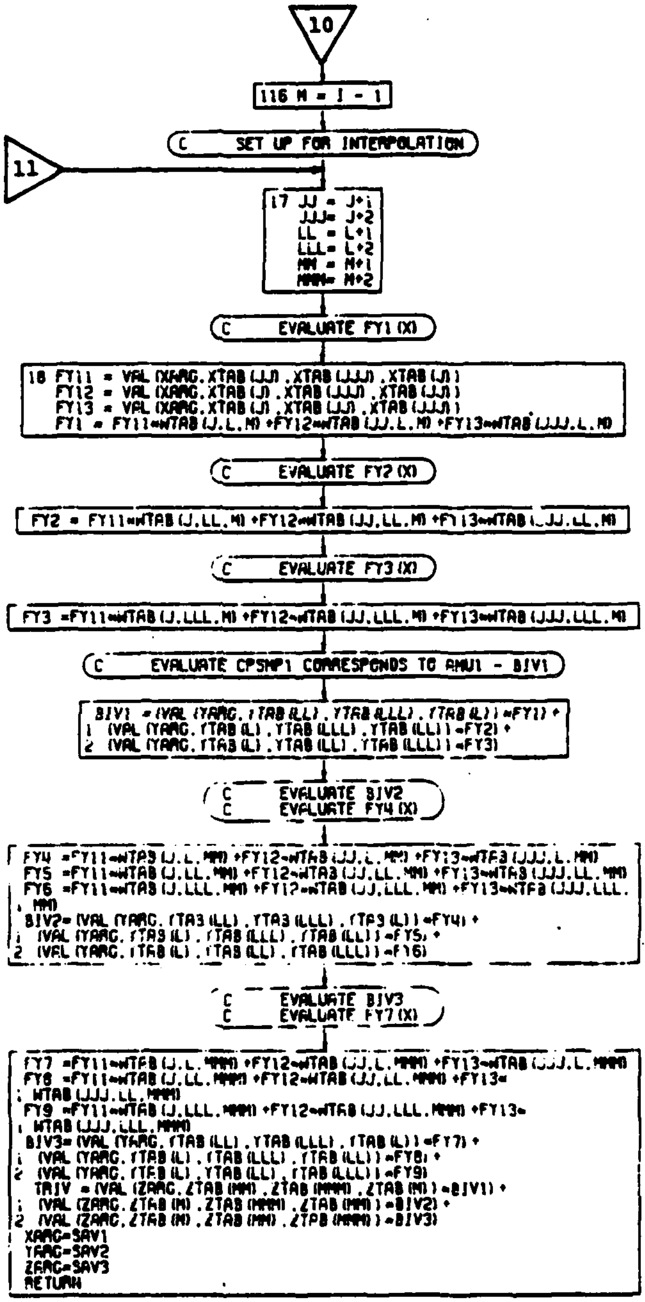

Figure 4-64. TRIV Function, Flow Chart (Part 5 of 7)

4.12.14 Function XLINT

XLINT performs a two-dimensional linear interpolation between two points. This subroutine is used extensively in subroutines ROTLIM and ROTPOW, and shown in flowchart form in Figure 4-65.

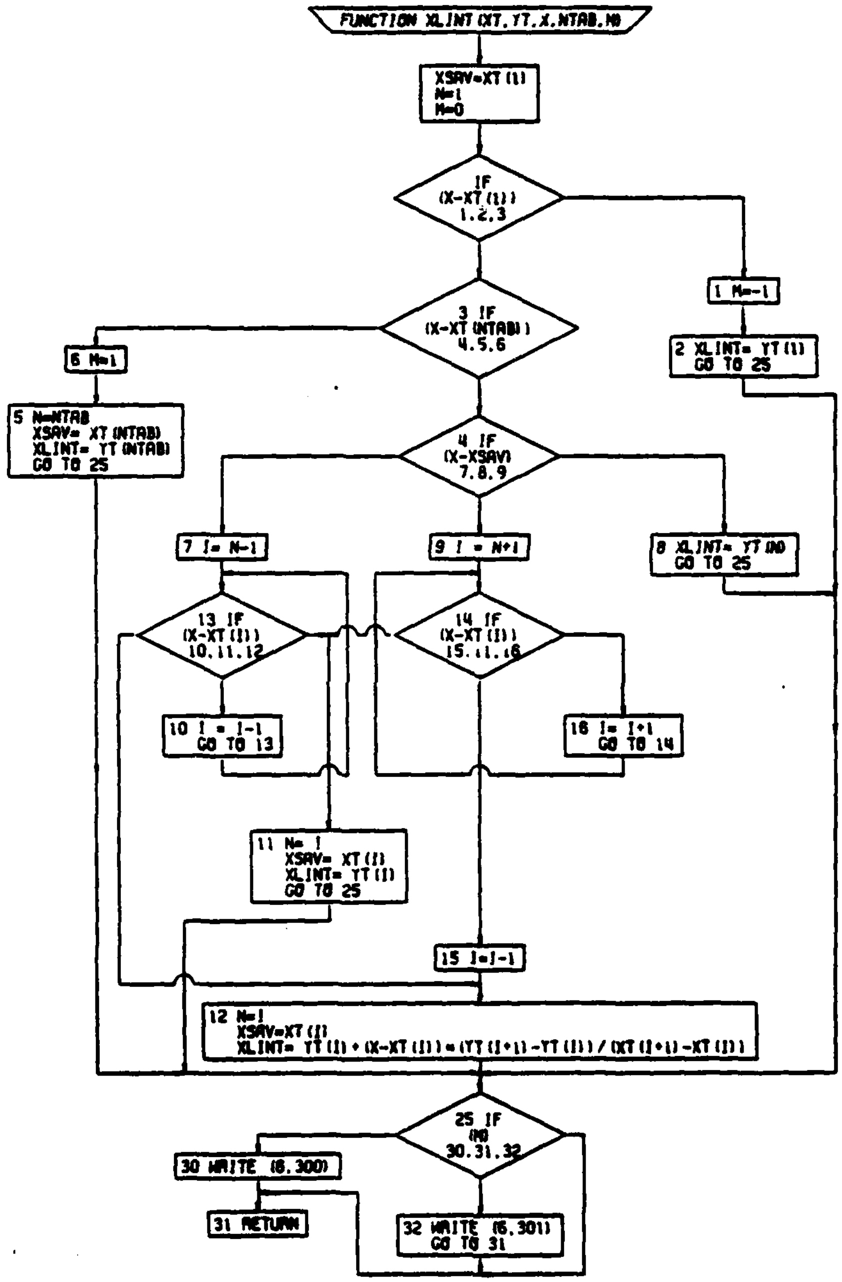

Figure 4-65. XLINT Function, Flow Chart

4.12.15 Function XLKUP

XLKUP is a double table parabolic look-up function. A flowchart of the subroutine is shown in Figure 4-66.

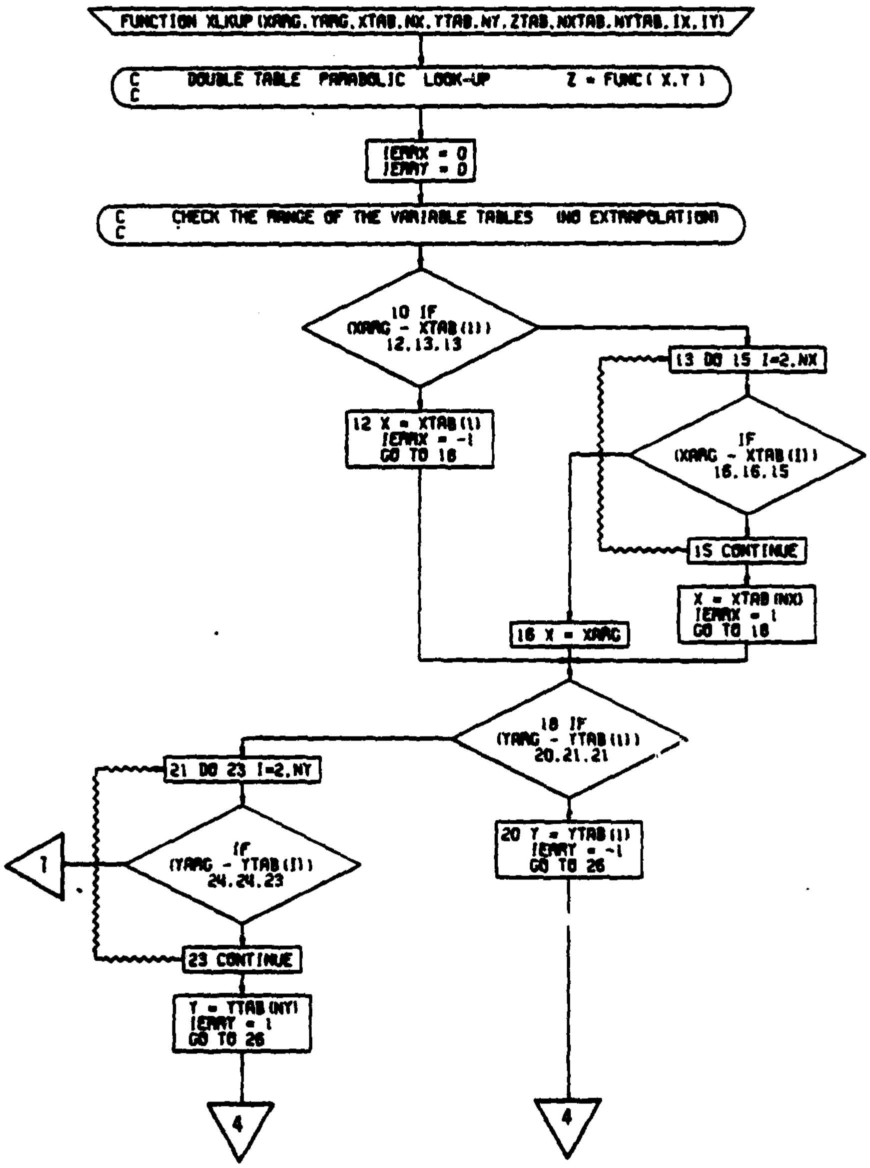

Figure 4-66. XLKUP Function, Flow Chart (Part 1 of 2)

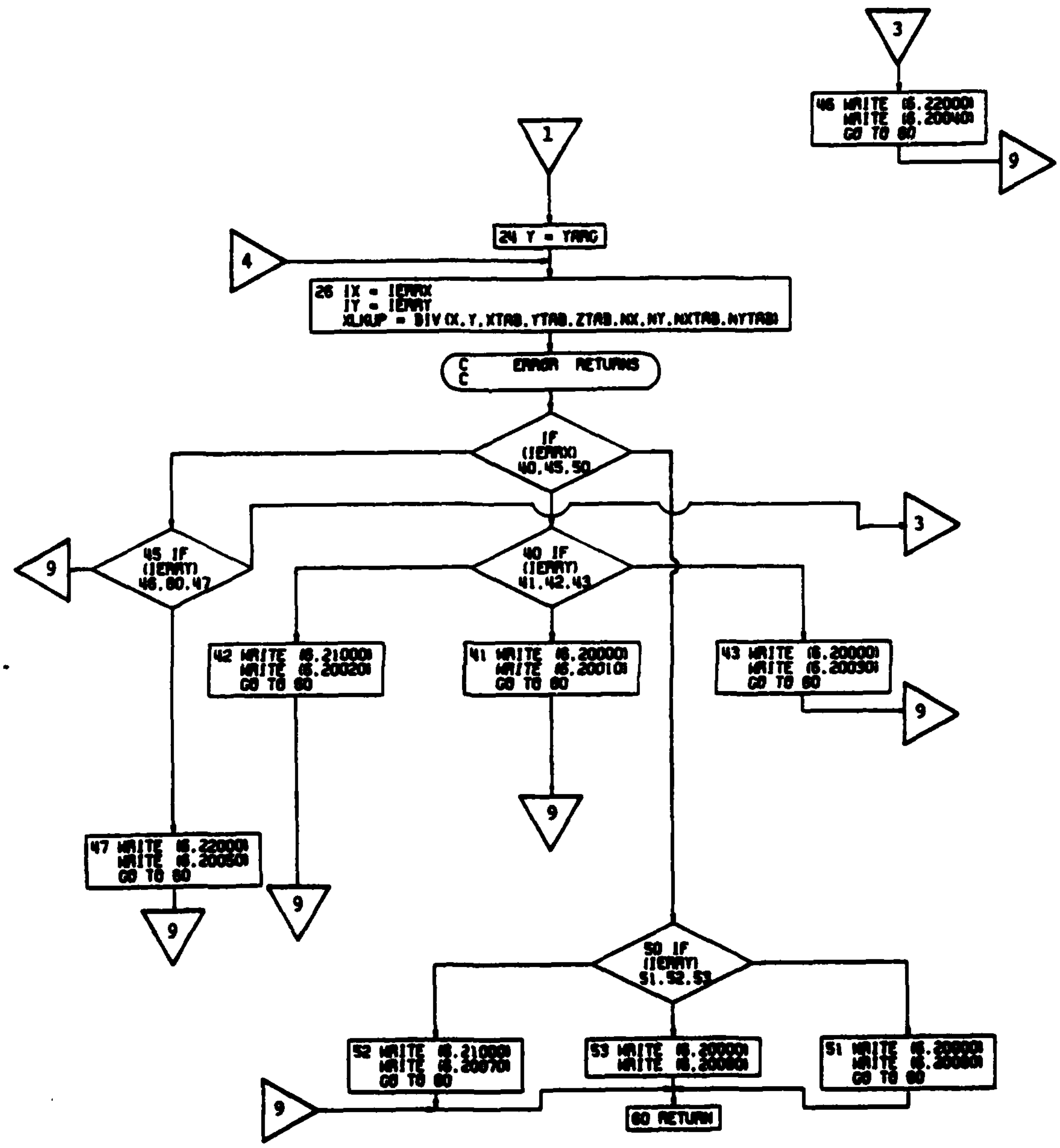

Figure 4-66. XLKUP Function, Flow Chart (Part 2 of 2)

4.12.16 Function XIBIV

XIBIV is an inverse double table parabolic look-up. A schematic of the flowchart is shown in Figure 4-67.

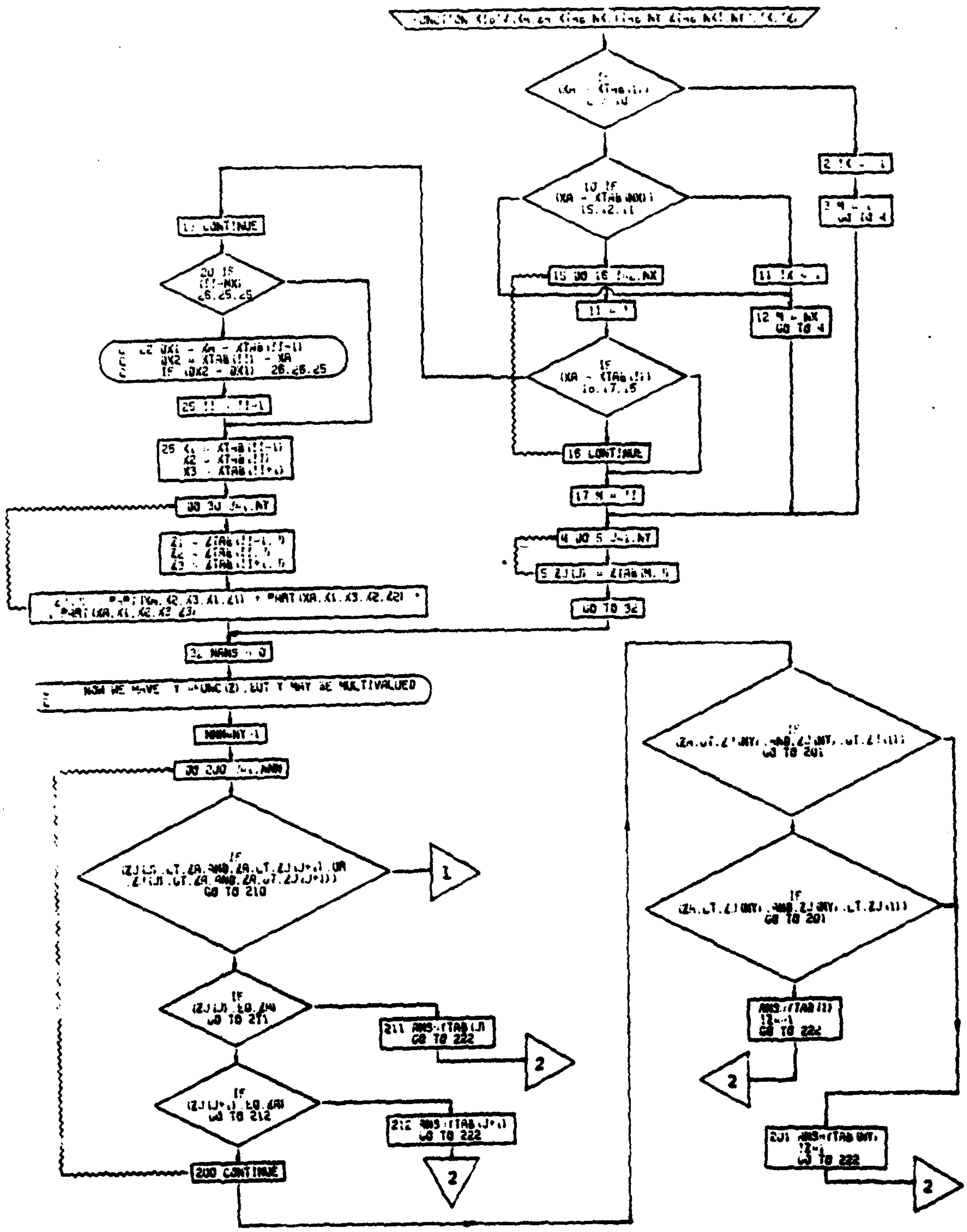

Figure 4-67. XIBIV Function, Flow Chart (Part 1 of 3)

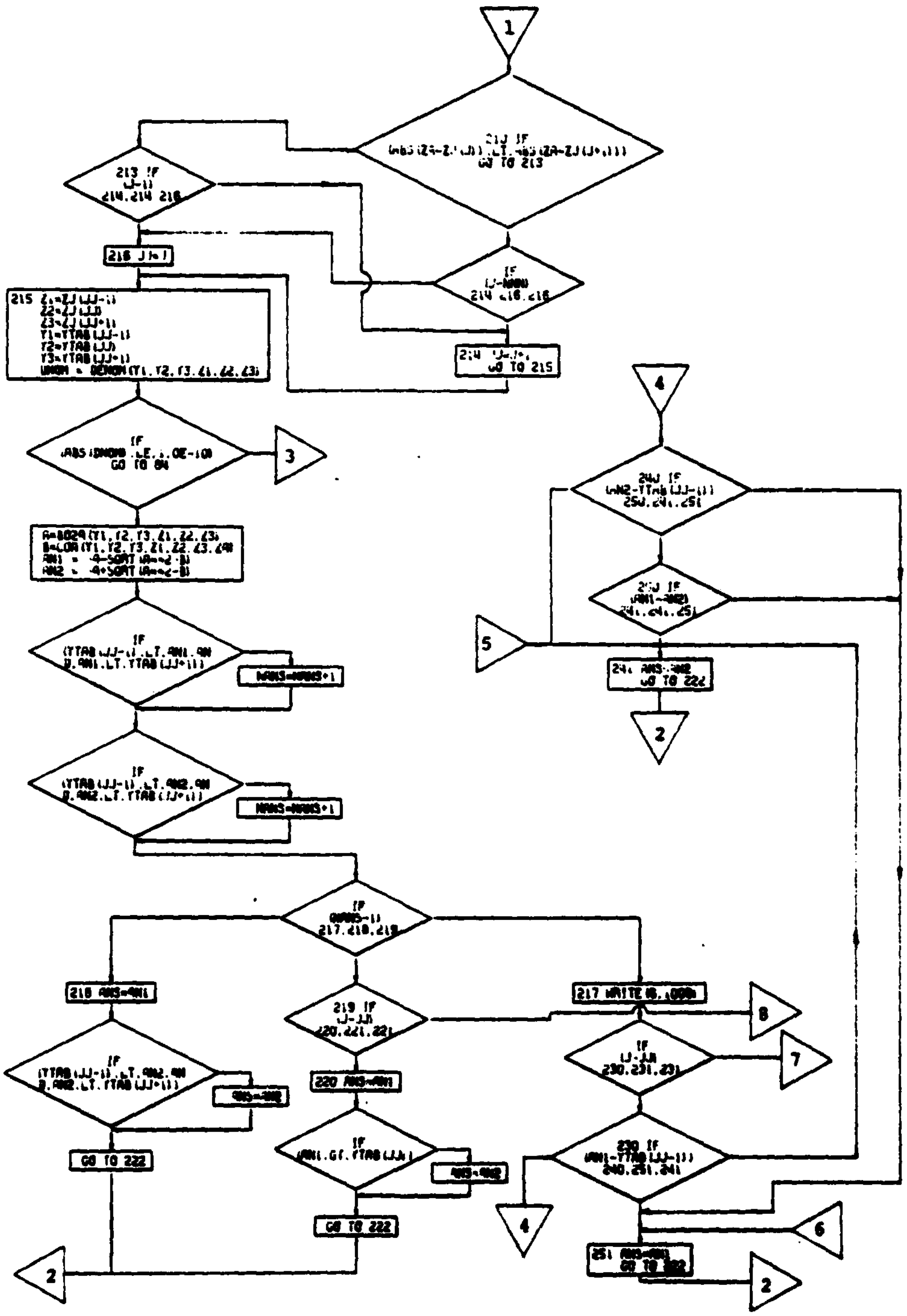

Figure 4-67. XIBIV Function, Flow Chart (Part 2 of 3)

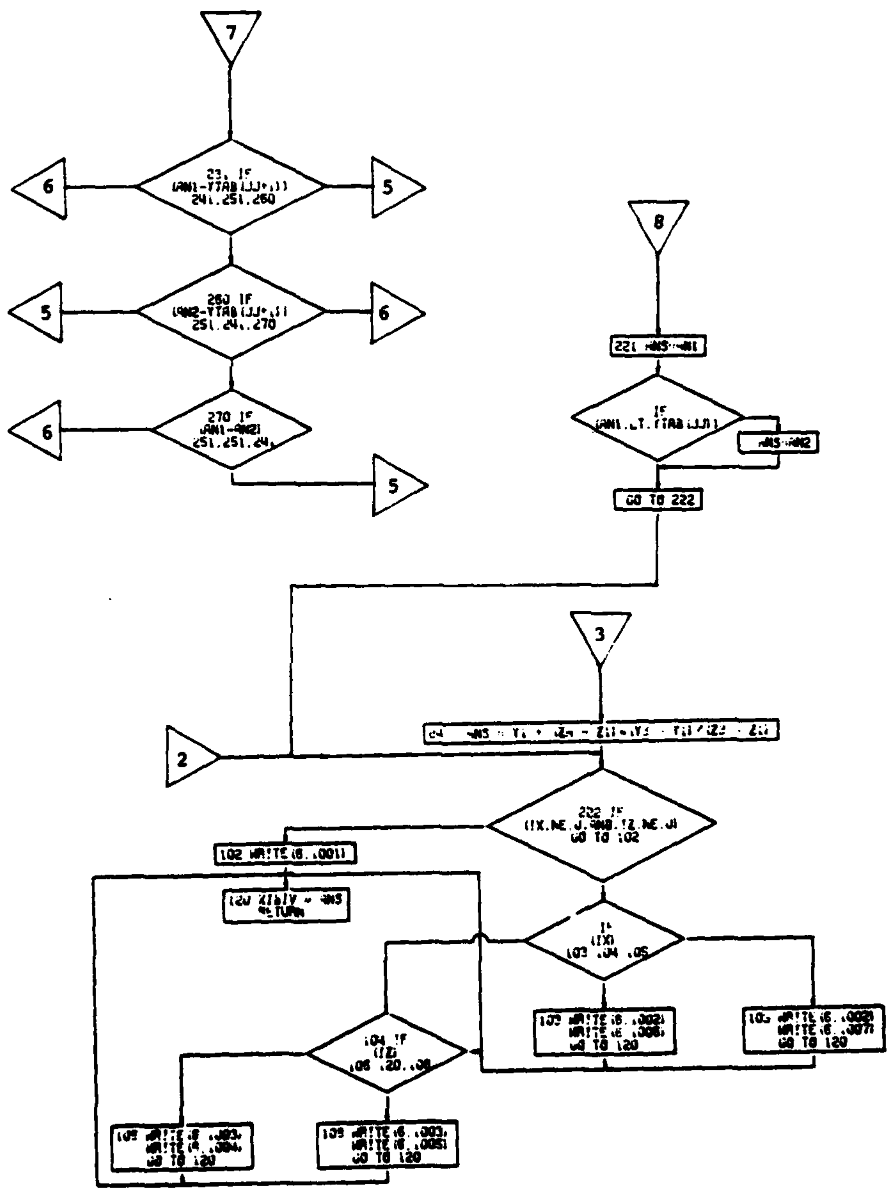

Figure 4-67. XIBIV Function, Flow Chart (Part 3 of 3)

5.1 GENERAL

Input to the program is made by means of a standard set of input sheets. Although there are large quantities of possible input, necessitated by the requirement to keep the program flexible and general, the input sheets have been configured to give maximum visibility and reduce the tediousness of inputting the data. This has been accomplished through several means:

1. All input of a similar nature has been grouped together. Thus, all dimensional information is on the same input sheet, regardless of whether it is used in the size trends subroutine or elsewhere.

2. The input sheets have been color-coded to distinguish between the data required in the sizing options (OPTIND = 0 or 1) and the much smaller amount of data required for performance calculations (OPTIND = 2 or 3).

3. Footnotes on the input sheets call attention to input which is not required due to selection of one of the optional paths or computation.

4. For parametric studies where only one or two variables are being changed from case to case, a special supplementary input sheet may be used, thus reducing the quantity of paper work.

5. All of the input sheets are generally not required for typical sizing and performance runs. For example, the rotor tip speed schedule, rotor incremental performance and auxiliary propulsion schedule are usually input only once and used in sucessive cases. In addition, the rotor cycles or maps, engine cycles and propeller performance maps (when required) are generally input and stored in libraries until called.

Altogether there are 43 different input sheets which can be loosely grouped into 10 categories: general information, aircraft descriptive information, mission profile information, rotor tip speed schedule, incremental rotor performance, auxiliary propulsion input schedule, engine cycle information, rotor performance information, propeller performance information, and supplementary input information. A specimen copy of each input sheet is included in this section. Descriptions of input variables, fortran names and program indicators are given in Section 5.3. For completeness, and to aid in trouble shooting, a subroutine cross reference is provided in Section 3.4. This section lists each subroutine and the subroutines it calls. The use of the various input sheets is discussed in subsequent paragraphs.

5.1.1 General Information

Input all primary program indicators (except those for specific mission segments, such as CRSIND), mission initial conditions, reserve fuel factors, and maneuver load factor. This sheet is always used.

5.1.2 Aircraft Description Information

5.1.2.1 Dimensional Information - Input characteristic geometric information for aircraft being studied. This includes information for sizing the airframe and the rotor (main and tail rotor if applicable). These sheets are used as appropriate.

5.1.2.2 Propulsion Information - Input data for numbers of primary and auxiliary independent propulsion engines, propellers, propeller cruise efficiencies, etc., and critical engine sizing conditions. There are three different input sheets for propulsion information: one for the primary engines (always used) and two for use with compound and auxiliary propulsion helicopter configurations. Of these two, one sheet is for propeller data and the other for auxiliary independent propulsion engine data.

5.1.2.3 Aerodynamics Information - Aircraft drag can be estimated two different ways. Either a detailed buildup or a trend can be used. For preliminary design, the trend is sufficiently accurate. In the case of a compound and winged helicopter, wing section lift/drag characteristics, two dimensional lift curve slope and Reynolds number/ft should be input. In addition, Kw (Loc 0327) should be input as 1.0.

5.1.2.4 Weights Information - Weights inputs are grouped according to the major aircraft groups. In addition, provisions are included to add incremental weights to each group as well as multiplicative factors which can be used to modify subsystem weights in each major group.

Operating weight empty (input only if OPTIND = 2 or 3), fixed equipment, fixed useful load and payload are input as lump sum numbers. Flight control inputs are broken down into the major groups of cockpit, rotor, system (upper controls), fixed wing SAS, and tilt mechanism controls. Inputs for auxiliary controls are also provided.

The inputs for structural weights include fuselage, landing gear, wings and tails. Crash load factors, nacelle and air induction system factors are also input. Provisions are included which account for concentrated loads on wing structure.

Propulsion group weights are subdivided into main rotor blades and hubs, tail and auxiliary rotors, main and auxiliary powerplant installation weights. Primary and auxiliary engine weights are input as part of the engine cycle data. The weights information sheet is always used when using OPTIND = 0, 1 and 3.0.

When MRPIND (LOC 0019) is set to either 1.0 or 2.0, the program will compute the main rotor position of a single rotor pure or compound helicopter based on a simple mass balance. If this option is used, the non-dimensional positions of the major subsystems must be input. If this option is not used, the main rotor non-dimensional position must be input. For most preliminary design studies, the rotor position is input.

5.1.2.5 Rotor Limits Information - Rotor limits information are always used. Limits are input in the form of rotor lift (C_T'/σ) as a function of propulsive force (C_X/σ) and rotor advance ratio μ. All tables must be input in ascending order and be 3 x 3 or greater. This table must be consistant with the C_T/σ values used in rotor sizing.

5.1.2.6 Non Standard Atmosphere Information - HESCOMP currently permits three atmosphere options. Standard atmosphere, standard atmosphere plus a constant change in temperature, and on arbitrary non standard atmosphere. This sheet is only used if a non standard atmosphere is used anywhere in the program.

5.1.3 Mission Profile Information

There are eight input sheets for mission profile information. These are not required when OPTIND = 0 (weights only). The sheets are:

1. Taxi Information
2. Takeoff, Hover, and Landing Information
3. Climb Information
4. Cruise Information
5. Descent Information
6. Loiter Information
7. Change of Weight and Transfer Altitude Information (incorporating change of fuel weight, change of payload weight, and transfer altitude)
8. General Performance

Each input variable on the mission profile sheets is represented by an array of ten input locations. The data for these locations is filled in sequentially by rows as the particular mission segment is used. For example, the first time that taxi is used in a particular case, the required input information is filled in on the first row of the input sheet.

Data for the second taxi of a case is filled in on the second row, and so on. Thus, up to ten of any particular segment may be used in a case.

5.1.4 Rotor Tip Speed Schedule

Rotor tip speed or advancing tip Mach number can be input as a function of forward flight Mach number. This option is most useful in simulating rotor speed reduction required for a compound helicopter flying to high speeds. If $N_{II}/N_{II_{max}}$ is input between 10 and 20, the program assumes the schedule is a mix of advancing tip Mach number and tip speeds. If $N_{II}/N_{II_{max}}$ is input greater than 20, then the program assumes tip speeds only are input.

If a tip speed schedule is not desired, the tip speed in each segment can be changed by inputting the appropriate value of $N_{II}/N_{II_{max}}$ in the segment. In this case, $N_{II}/N_{II_{max}}$ is always input less than 10. This sheet will generally not be required for anything but a high speed helicopter. Additional explanation is found in Section 5.3, Program Input, and in the sample cases.

5.1.5 Auxiliary Propulsion Schedule Input

When studying a propulsively unloaded compound helicopter, the propulsive unloading ratio (Taux/T) in segments 2, 3, 4, 5, 6 and 11 can be specified in three ways. If Taux/T is input <1000 (typically between 0.0 and approximately 1.2) in the segments noted, the program uses them as input. If the Taux/T inputs in the noted segments are input equal to 1000, the auxiliary propulsive schedule as a function of advance ratio μ is used by the program. If the Taux/T inputs in segments 2, 3, 4, 5, 6 and 11 are set equal to 2000, the input auxiliary propulsion schedule is used up to the transition advance ratio indicated by location 1692. Above that advance ratio, the Taux/T corresponding to maximum rotor or configuration L/D_e is used. Additional explanation is included in Section 5.3, Program Input, and in the sample cases.

5.1.6 Engine Cycle Information

The engine cycle sheets may be used to input engine cycle data when one of the standard engine cycles is not used. The three engine cycle sheets are divided into standard performance information and nonstandard performance information. The standard performance data, of which there are

two sheets, represent the performance of idealized engine cycles. These data are unlimited except for the effect of engine ratings, which are dictated by values of turbine temperature. The nonstandard performance represents limiting values of fuel flow, torque, rpm and other nonstandard effects. It should be noted that auxiliary independent engine input data can be created from the HESCOMP engine cycle library data simply by the input of the applicable engine cycle IBM card deck, preceded and followed by a "66666" card. Nonstandard auxiliary independent engine performance is input using the sheet provided for that purpose. The engine non-dimensionalized weight and dimensions are input on these sheets. Engine cycle data are always required.

5.1.7 Rotor Performance Data

Rotor performance is calculated either by the short form rotor performance method (ROTIND = 1) or using input maps of rotor performance as a function of lift and propulsive force (ROTIND = 2 to 6). The short form rotor performance methodology (ROTIND = 1.0) is a combination of momentum theory and empirically derived factors. The option is used when the performance of a conventional rotor is desired. In addition, the input coefficients can be modified to simulate more advanced rotor cycles.

Alternatively, rotor performance data may be input in "map" form (ROTIND = 2, 3 in the case of Type I "maps" and ROTIND = 4, 5, 6 for Type II "maps") using the ten input sheets (combined total of Types I and II) provided for this purpose. The first sheet is for hover performance data which is input as a table of C_{P_H}/σ as a function of C_T/σ and M_{TIP} in the case of Type I "Map" and F.M. as a function of C_T/σ and M_{TIP} in the case of the Type II "map". The remaining four sheets are for cruise performance data which is input as a table of C_P/σ as a function of μ, C_T'/σ, and C_X/σ for the Type I "map" and L/D_E as a function of μ, C_T'/σ, and X/L for the Type II "map". When ROTIND = 5 and 6, rotor performance is optimized for either best rotor or best overall configuration L/D_E.

5.1.8 Propeller Performance Data

Propeller performance computations are input to the program in three ways. In the first (η_p IND = 0), propeller efficiencies are input as a function of flight Mach number. This is generally the most convenient way of conducting parametric studies. In the second (η_p IND = 1), a complete map of a known propeller is used. Values of propeller power coefficient are input for combinations of propeller advance ratio and thrust coefficient. This option requires that a propeller has been defined and complete performance information is available from some other source.

The third method provided is to allow the program to calculate propeller performance using a short method when propeller geometry is either known or assumed. The user need only specify the number of blades (3 or 4), the activity factor per blade and the integrated lift coefficient, C_{L_i}. The method used is the short method originated at the Curtis-Wright Corporation (Reference 10) and involves the use of a set of equations which are developed from strip theory, and includes the effects of compressibility on performance. This option should be used primarily when a propeller has already been selected and performance is desired.

5.1.9 Supplementary Information

The supplementary input sheet may be used for the second and subsequent cases of a parametric study. For example, in the case of a tandem rotor helicopter, if the user wishes to change both the rotor overlap/diameter ratio (location 0132 - see dimensional information sheet) and the disc loading (location 0173 - see dimensional information sheet), these locations and their new values may be filled in on the supplementary input sheet.

Five typical problems, from input to output, are discussed in Section 7.3 of this manual.

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO. OF	CASE NO.

GENERAL INFORMATION

TITLE CARD (72) (DIGITS)

7 10 13 16 19 22 25 28 31 34 37 40 42

43 46 49 52 55 58 61 64 67 70 73 76 78

	VARIABLE	UNIT	LOC.	VALUE	
OPTION INDICATOR	OPTIND		0001		0 = AIRCRAFT WEIGHT 1 = SIZE AIRCRAFT 2 = PERFORMANCE ONLY 3 = FUEL ITERATION
PRINT INDICATOR	OPTIONAL PRINT		0002		0 = STD PRINT 1 = DETAILED PRINT
AERO-DYNAMICS INDICATORS	DRGIND		0003		1 = COMPONENT DRAG BUILD-UP 2 = (GW/fe) DRAG TREND
	OSWIND		0004		0 = INPUT e 1 = PROG. CALC. e
1ST ORDER SIZE TREND AND PRO-PULSION INDICATORS (ALWAYS INPUT)	CNFIND		0005		1 = SINGLE ROTOR 2 = TANDEM ROTOR
	AUXIND		0006		1 = PURE HELICOPTER 2 = INCLUDING WINGS (ONLY) 3 = INCL. AUX. PROPULSION (ONLY) 4 = COMPOUND (WINGS & AUX. PROP)
	RDMIND		0007		1 = INPUT D_{MR}, σ 2 = INPUT W/A, σ 3 = INPUT D_{MR}, C_T/σ 4 = INPUT W/A, C_T/σ
	FIXIND		0008		0 = INPUT FIXED SIZE PRIM. ENG. 1 = PROG. SIZE PRIM. ENG.
	ROTIND		0009		1 = SHORT FORM ROTOR PERF. 2,3, = ROTOR MAP INPUT 4,5,6 = L/D_e ROTOR MAP INPUT
2ND ORDER SIZE TREND AND PRO-PULSION INDICATORS (OPTIONAL INPUT)	S_WIND	NOTE a	0010		1 = INPUT S_W 2 = INPUT W/S 3 = SIZE FOR MANEUVER
	b_WIND	NOTE a	0011		1 = INPUT b_W/D 2 = INPUT AR 3 = DETER BY PROP CLEAR
	AIPIND	NOTE b	0012		1 = NO INDEP. AUX. ENGINES 2 = INDEP. AUX. ENGINES
	ENGIND	NOTE c	0013		0 = T/SHAFT INDEP. AUX. ENG. 1 = T/FAN OR T/JET INDEP. AUX. ENG.
	FIXINDI	NOTE c	0014		0 = INPUT FIXED SIZE AUX. INDEP. ENG. 1 = PROG. SIZE AUX. INDEP. ENG.
	TRDIND	NOTE d	0015		0 = NO TAIL ROTOR 1 = PROG. USES D_{TR} TREND 2 = INPUT D_{TR} 3 = INPUT (T/A) NET
	TRSIND	NOTE d	0016		1 = INPUT σ_{TR} 2 = INPUT C_T/σ
	VTFIND	NOTE d	0017		1 = INPUT AR_{VT}, ζ_{VT} 2 = INPUT $C_{L_{DES}}$ V_{DES}, ζ_{VT} 3 = INPUT $C_{L_{DES}}$, V_{DES}, AR_{VT}
	HTIND	NOTE d	0018		0 = NO HOR. TAIL 1 = FIXED SIZE HOR. TAIL 2 = INPUT TAIL VOL. COEFF.
	MRPIND	NOTE d	0019		0 = INPUT x_M/l_B 1,2 = PROG. CALC x_M/l_B
	FDMIND	NOTE e	0020		1 = INPUT((O/L)/D), ROTOR POSN'S 2 = INPUT((O/L)/D), l_C 3 = INPUT l_C, ROTOR POSN'S
	APHIND	NOTE e	0021		1 = INPUT h_{P_2} 2 = INPUT g/S
	ESCIND	NOTE f	0022		1 = SIZE PRIM. ENG. FOR T/O ONLY 2 = SIZE PRIM. ENG. FOR T/O OR CRUISE
INITIAL CONDITIONS	WG_O	LBS	0023		GROSS WEIGHT
	h_O	FT	0024		ALTITUDE
	R_O	NM	0025		RANGE
	t_O	HR	0026		TIME
FLIGHT PATH CONTROL INDICATOR	$h_{OPT_{IND}}$		0027		0 = CRUISE @ SPECIFIED ALT. 1 = CRUISE @ OPT. ALT.
LIMITING SPEED	M_{MO}		0028		MACH NO.
	V_{MO}	KTS EAS	0029		EAS
	V_{DIVE}	KTS EAS	0030		
MANEUVER LOAD FACTOR	M_{LF}		0031		
RESERVE FUEL FACTORS	K_I		0032		NOM. = 1.0
	δW_F	LBS	0033		NOM. = 0.0
	K_{FF}		0034		FUEL FLOW MULTIPLIER NOM. = 1.0

MISSION PROFILE INFORMATION

MAXIMUM OF 50 CONSECUTIVE SEGMENTS

VALUES OF SGTIND

0 = END OF MISSION
1 = TAXI
2 = T.O., HOVER, LAND
3 = CLIMB
4 = CRUISE
5 = DESCENT
6 = LOITER
7 = CHANGE FUEL
8 = CHANGE PAYLOAD
9 = TRANSFER ALTITUDE
11 = GENERAL PERFORMANCE

100 = END OF CASE

	LOC.	VALUE		LOC.	VALUE
1st	0035		26th	0060	
2nd	0036		27th	0061	
3rd	0037		28th	0062	
4th	0038		29th	0063	
5th	0039		30th	0064	
6th	0040		31st	0065	
7th	0041		32nd	0066	
8th	0042		33rd	0067	
9th	0043		34th	0068	
10th	0044		35th	0069	
11th	0045		36th	0070	
12th	0046		37th	0071	
13th	0047		38th	0072	
14th	0048		39th	0073	
15th	0049		40th	0074	
16th	0050		41st	0075	
17th	0051		42nd	0076	
18th	0052		43rd	0077	
19th	0053		44th	0078	
20th	0054		45th	0079	
21st	0055		46th	0080	
22nd	0056		47th	0081	
23rd	0057		48th	0082	
24th	0058		49th	0083	
25th	0059		50th	0084	

NOTES: INPUT ONLY IF:
a. AUXIND = 2,4
b. AUXIND = 3,4
c. AIPIND = 2
d. CNFIND = 1
e. CNFIND = 2
f. FIXIND = 1

NOTE: **WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS**

FORM 83110 (8/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO. OF	CASE NO.

HELICOPTER DIMENSIONAL INFORMATION

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

† ~ WHEN CNFIND = 1.0, VTFIND = 1.0, TRDIND = 0.0 } K_z = VERTICAL TAIL SPAN (b_{VT})

GROUP	NOTE	VARIABLE	UNIT	LOC.	VALUE
WING	a	S_W	FT²	0101	
	b	W/S	PSF	0102	
	c	b_W/D		0103	
	d	AR		0104	
		$(t/c)_R$		0105	
		$(t/c)_T$		0106	
		$\Lambda_{C/4}$	DEG	0107	
		λ		0108	
	e	C_F/C		0109	NOM = 1.0
		h'/h_F		0110	
	f	C_{L_D}		0111	
HOR. TAIL		AR_{HT}		0112	
		l_{TH}'		0113	
		$(t/c)_{HT}$		0114	
	g	$\bar{V}_H$		0115	
		λ_H		0116	
	h	S_{HT}	FT²	0117	
AUX. PROP.	i	Y_{CL}	FT	0118	
	i	ζ_2		0119	

(IF LOCATED ON WING)

GROUP	NOTE	VARIABLE	UNIT	LOC.	VALUE
GEN.		$\Delta S_{WET}/S_F$		0120	
		ΔS_{WET}	FT²	0121	

GROUP	NOTE	VARIABLE	UNIT	LOC.	VALUE
BODY		h_F	FT	0122	
		W_F	FT	0123	
		$(l/d)_P$		0124	
		$(l/d)_T$		0125	
		l_C	FT	0126	
		l_{RW}	FT	0127	
	j	(X_M/l_B)		0128	
	k	$(l_{TB}/d_{\bar{T}B})$		0129	
	k	$(d_{\bar{T}TB}/d_{\bar{T}B})$		0130	
	k	$k_{T\ STING}$		0131	
	l	$((D/L)/D)$		0132	
	m	$(\Delta x_1/l_P)$		0133	
	m	$(\Delta x_2/l_T)$		0134	
VERT. TAIL	n	AR_{VT}		0135	
		λ_{VT}		0136	
		$(t/c)_{VT}$		0137	
	p	ζ_{VT}		0138	
	†	K_Z OR b_{VT}		0139	
	q	$C_{L_{DES}}$		0140	
	q	V_{DES}	KTS TAS	0141	
PRIM. ENG. NAC.		γ_1		0142	
		γ_2		0143	
		γ_3		0144	
		(l_{AIP}/l_C)		0145	
AUX. IND. ENG. NAC.	r	γ_4		0146	
	r	γ_5		0147	
	r	γ_6		0148	
	r	(l_{AIA}/l_{OA})		0149	
	r	$\Delta S/S_{STR}$		0150	
	r	$b_{NS}/d_{\bar{N}I}$		0151	

NOTES: INPUT NOT NECESSARY WHEN:

- a. S_WIND = 2,3
- b. S_WIND = 1,3
- c. b_WIND = 2,3
- d. b_WIND = 1,3
- e. AUXIND = 1,3
- f. S_WIND = 1,2
- g. HTIND = 1
- h. HTIND = 2
- i. b_WIND = 1,2
- j. MRPIND = 1,2
- k. CNFIND = 2
- l. FDMIND = 3
- m. FDMIND = 2
- n. VTFIND = 2
- p. VTFIND = 3
- q. VTFIND = 1
- r. AIPIND = 2

FORM 53111 (8/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

ROTOR DIMENSIONAL DATA FOR SIZING MAIN ROTOR(S)

ROTOR MAP NO.	0170	
ROTOR CYCLE NO.	0171	

ROTOR CHARACTERISTICS

NOTE	VARIABLE	UNIT	LOC.	VALUE
†	N_R		0172	
a	W/A	PSF	0173	
b	D_{MR}	FT	0174	
c	σ_{MR}		0175	
	b_{MR}		0176	
	$\theta_{T_{MR}}$	DEG	0177	
	$X_{C_{MR}}$		0178	
	X_{MR}		0179	
	(t/c) .25R		0180	
	$V_{TIP_{REF}}$	FPS	0181	

HOVER COND. FOR ROTOR SIZING

NOTE	VARIABLE	UNIT	LOC.	VALUE
d	$(C_T/\sigma)_H$		0182	
d	T/W		0183	

CRUISE COND FOR ROTOR AND WING SIZING

NOTE	VARIABLE	UNIT	LOC.	VALUE
	$V_{KT}(c)$	KTS TAS	0184	
	$h_C(c)$	FT	0185	
	ΔTINC	°F	0186	
d	$(C_T/\sigma)_{CR}$		0187	
	g REQM'T		0188	
	g (ROTOR)		0189	
	N (ROTOR LOADING)		0190	

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

ROTOR VERTICAL R/C EFFICIENCY FACTORS

	V_{CEH1}		0191	
	V_{CEH2}		0192	

INCREMENTAL ROTOR FIGURE OF MERIT INPUT

	Δ F.M.		0195	

† IF NO. OF ROTORS = 1, MUST ADD TAIL ROTOR SIZING SHT.

ROTOR CLIMB & DESCENT EFFICIENCIES

	$K_{P\ CLIMB}$		0193	
	$K_{P\ DESCENT}$		0194	

NOTES: INPUT NOT NECESSARY WHEN
a. RDMIND = 1,3
b. RDMIND = 2,4
c. RDMIND = 3,4
d. RDMIND = 1,2

FORM 93116 (6/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

ROTOR DIMENSIONAL DATA FOR SIZING MAIN ROTOR(S)

ROTOR MAP NO.	0170	
ROTOR CYCLE NO.	0171	

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

	NOTE	VARIABLE	UNIT	LOC.	VALUE
ROTOR CHARACTERISTICS	†	N_R		0172	
	a	W/A	PSF	0173	
	b	D_{MR}	FT	0174	
	c	σ_{MR}		0175	
	c	b_{MR}		0176	
		$\theta_{T_{MR}}$	DEG	0177	
		$X_{C_{MR}}$		0178	
		X_{MR}		0179	
		(t/c) .25R		0180	
		$V_{TIP_{REF}}$	FPS	0181	
HOVER COND. FOR ROTOR SIZING	d	$(C_T/\sigma)_H$		0182	
	d	T/W		0183	
CRUISE COND FOR ROTOR AND WING SIZING		$V_{KT}(c)$	KTS TAS	0184	
		$h_C(c)$	FT	0185	
		ΔTINC	°F	0186	
	d	$(C_T/\sigma)_{CR}$		0187	
		g REQM'T		0188	
		g (ROTOR)		0189	
		N (ROTOR LOADING)		0190	

ROTOR VERTICAL R/C EFFICIENCY FACTORS		V_{CEH1}		0191	
		V_{CEH2}		0192	

INCREMENTAL ROTOR FIGURE OF MERIT INPUT		Δ F.M.		0195	

† IF NO. OF ROTORS = 1, MUST ADD TAIL ROTOR SIZING SHT.

ROTOR CLIMB & DESCENT EFFICIENCIES		$K_{P\ CLIMB}$		0193	
		$K_{P\ DESCENT}$		0194	

NOTES: INPUT NOT NECESSARY WHEN
a. RDMIND = 1,3
b. RDMIND = 2,4
c. RDMIND = 3,4
d. RDMIND = 1,2

FORM 53116 (8/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

ROTOR DIMENSIONAL DATA FOR SIZING TAIL ROTOR (CNFIND = 1)

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

TAIL ROTOR CHARACTERISTICS

NOTE	VARIABLE	UNIT	LOC	VALUE
a	(T/A) NET	PSF	0200	
b	[illegible]	FT	0201	
c	[illegible]		0202	
[illegible]	[illegible]		0203	
[illegible]	[illegible]	DEG	0204	
[illegible]	[illegible]		0205	
	X_{TR}		0206	
[illegible]	[illegible]	FPS	0207	

TAIL ROTOR SIZING COND.

NOTE	VARIABLE	UNIT	LOC	VALUE
d	$(C_T/\sigma)_{DES\ (H)}$		0208	
	YAW ACCEL ($\ddot{\psi}$)	$\frac{RAD}{SEC^2}$	0209	
	YAW RATE ($\dot{\psi}$)	$\frac{RAD}{SEC}$	0210	
e	$(C_{T_G}/C_{T_{NET}})$		0211	
e	$\bar{C}$		0212	
d	Kzzz		0213	
f	$g_{MR/TR}$	FT	0214	
d	K_{TRS}		0215	

NOM. = 1.0

NOTE	VARIABLE	UNIT	LOC	VALUE
	$C_{L_{FIN}}$		0216	

NOTES:
a. INPUT NOT NECESSARY WHEN TRDIND = 1.2
b. INPUT NOT NECESSARY WHEN TRDIND = 1.3
c. INPUT NOT NECESSARY WHEN TRSIND = 2
d. INPUT NOT NECESSARY WHEN TRSIND = 1
e. IF OPTIND = 1, $(C_{T_G}/C_{T_{NET}})$ MAY BE INPUT AS 1.00, AND A VALUE OF $\bar{C}$ INPUT, PROGRAM WILL THEN CALCULATE A VALUE OF $(C_{T_G}/C_{T_{NET}})$. IF VALUE OF $(C_{T_G}/C_{T_{NET}}) > 1.0$ INPUT, IT IS NOT NECESSARY TO INPUT $\bar{C}$.
f. IF CNFIND = 1.0 AND TRDIND = 0, $g_{MR/TR}$ IS THE GAP FROM THE MAIN ROTOR TIP TO THE END OF THE FUSELAGE.

g	B_{TRS}/B_{FAN}		0282		NOM. = 1.0
h	$FANOP_H$		0283		NOM. = 0.0
i	$FANOP_C$		0284		NOM. = 0.0

NOTES:
g. INPUT USED TO SIMULATE "FENESTRON" SHROUDED TAIL ROTOR.
h. IF $FANOP_H$ INPUT AS 1.00, TAIL ROTOR/FAN SHUT DOWN IN HOVER.
i. IF $FANOP_C$ INPUT AS 1.00, TAIL ROTOR/FAN SHUT DOWN IN CRUISE.

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

HELICOPTER PROPULSION INFORMATION REQUIRED FOR PRIMARY ENGINE SIZING

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

		PRIMARY ENGINE CYCLE NO.		0217	

GROUP	NOTE	VARIABLE	UNIT	LOC	VALUE
PRIMARY ENGINE DATA	a	SHP^*_P	HP	0218	
		N_P		0219	
MAIN XMSN & ACC DATA		XMSNIND		0220	
		SHP_{MRX}/SHP^*_{MR}		0221	
	b	$K_{ALT\ PAYL}$		0222	
		η_T		0223	
		ΔSHP_{ACC}	HP	0224	
T. ROTOR & AUX DRIVE SYS XMSN DATA		SHP_{TRX}/TRP^*		0225	
		SHP_{AUX}/SHP^*_{AUX}		0226	

GROUP	NOTE	VARIABLE	UNIT	LOC	VALUE
T/O COND FOR ENG SIZING		$h_{TO(H)}$	FT	0227	
		$(T/W)_D$		0228	
		$\Delta T_{IN\ TO}(H)$	°F	0229	
		$\left(\frac{N_{II}}{N_{II\,MAX}}\right)_{TO}$		0230	
		N_{PSD}		0231	
		SHP_E/SHP^*		0232	
		$(V_{R/C})_D$	FPM	0233	
CRUISE COND FOR PRIMARY ENGINE & AUXILIARY ENGINE SIZING		POWIND		0234	
		h_C	FT	0235	
		V_C	KTS TAS	0236	
		ΔT_{INCE}	°F	0237	
		$(N_{II}/N_{II\,MAX})_C$		0238	
	c	$(T_{AUX}/T_{TOT})_C$		0239	
	d	$C_{L_{D_P}}$		0240	
		$(N_{PSD})_C$		0241	

0 = MAX POWER
1 = MIL POWER
2 = NORMAL POWER

NOTES:
a. INPUT NOT NECESSARY WHEN FIXIND = 1
b. INPUT NOT NECESSARY WHEN XMSNIND = 1,2
c. INPUT NOT NECESSARY WHEN AUXIND = 1,2
d. INPUT NOT NECESSARY WHEN AUXIND = 1,3

HELICOPTER PROPULSION INFORMATION REQUIRED FOR SEPARATE AUXILIARY CRUISE ENGINE SIZING (AIPIND = 2)

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

AUX PROPULSION ENGINE CYCLE NO.	0242	

	NOTE	VARIABLE	UNIT	LOC	VALUE
AUX PROPULSION ENGINE DATA	a	SHP^*_I	HP	0243	
	a	F_N^*	LBS	0244	
		N_p		0245	
CRUISE CONDITIONS FOR AUX. PROPULSION ENGINE SIZING		POWIND		0246	0 = MAX POWER 1 = MIL POWER 2 = NORMAL POWER
		$(N_{II}/N_{II_{MAX}})_I$		0247	

NOTES: a. INPUT NOT NECESSARY WHEN FIXINDI = 1.

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

PROPELLER DATA REQUIRED FOR COMPOUND HELICOPTER AUXILIARY PROPULSION (T/SHAFT ENGINES)

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

NOTE	VARIABLE	UNIT	LOC	VALUE
	NO. OF PROPS		0248	
	$V_{T_{AR}}$	FPS	0249	
	DIA	FT	0250	
	X_{AR}		0251	
	$\eta_{T\,AUX}$		0252	

	η_p IND		0253	

0 = INPUT η_p'S
1 = INPUT PROP TABLE
2 = PROG CALC PROP PERF.

0: η_p IND = 0

VALUES OF EFFICIENCY

	NOTE	VARIABLE	UNIT	LOC	VALUE
CLIMB		η_{P3}		0254	
DESCENT		η_{P5}		0255	

NOTE	VARIABLE	UNIT	LOC	VALUE
	AF/BLADE		0257	
	NO. OF BLADES		0258	

η_{P4}: CRUISE & LOITER

NO. OF PAIRS IN η_{P4} TABLE	0261	

	LOC	VALUE		LOC	VALUE
VALUES OF M	0262		VALUES OF η_{P_4}	0272	
	0263			0273	
	0264			0274	
	0265			0275	
	0266			0276	
	0267			0277	
	0268			0278	
	0269			0279	
	0270			0280	
	0271			0281	

1: $\eta_{P_{IND}}$ =1

NOTE	VARIABLE	UNIT	LOC	VALUE
	AF/BLADE		0257	
	NO. OF BLADES		0258	

η_{P_6}	0259	
PROP TABLE NO.	0260	

NOTE: ALSO INPUT PROP TABLE (LOCS. 1700→2142)

2: $\eta_{P_{IND}}$=2

NOTE	VARIABLE	UNIT	LOC	VALUE
	AF/BLADE		0257	

NO. OF BLADES	0258	
C_{L_i}	0260	
η_{P_6}	0259	

HELICOPTER AERODYNAMICS INFORMATION

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

NOTE	VARIABLE	LOC.	VALUE
a	$C_{D_{VT\,i}}$	0301	
a	$C_{D_{HT\,i}}$	0302	
b	$C_{D_{AP}}$	0303	
	$C_{D_{FP}}$	0304	
	$C_{D_{CSMR}}$	0305	
	$C_{D_{SHMR}}$	0306	
a	$C_{D_{CSTR}}$	0307	
a	$C_{D_{SHTR}}$	0308	
	C_{D_N}	0309	
	$C_{D_{NI}}$	0310	
	$C_{D_{NS}}$	0311	
c	(Gw/F_e)	0312	
c	K_{FED}	0313	
d	e	0314	
a	TFEF	0315	
e	ΔFe_{FT^2}	0316	

NOTE	VARIABLE	LOC.	VALUE
a	K_{VT}	0317	
a	K_{HT}	0318	
b	K_{AP}	0319	
	K_{FP}	0320	
	K_{HPIM}	0321	
a	K_{HPIT}	0322	
	K_N	0323	
	K_{NI}	0324	
	K_{NS}	0325	
	K_F	0326	
	K_W	0327	

f	$(Re/l)_i$	0328	
f	C_{l_α} RAD^{-1}	0329	

WING PROFILE DRAG AS FUNCTION OF C_L

NO. OF PAIRS IN TABLE	0330	

	$C_{Lw}(1)$	0331	
	$C_{Lw}(2)$	0332	
	$C_{Lw}(3)$	0333	
	$C_{Lw}(4)$	0334	
	$C_{Lw}(5)$	0335	
	$C_{Lw}(6)$	0336	
	$C_{Lw}(7)$	0337	
	$C_{Lw}(8)$	0338	

	$C_{D_{w\,i}}(1)$	0339	
	$C_{D_{w\,i}}(2)$	0340	
	$C_{D_{w\,i}}(3)$	0341	
	$C_{D_{w\,i}}(4)$	0342	
	$C_{D_{w\,i}}(5)$	0343	
	$C_{D_{w\,i}}(6)$	0344	
	$C_{D_{w\,i}}(7)$	0345	
	$C_{D_{w\,i}}(8)$	0346	

NOTE: C_{Lw}, $C_{D_{w\,i}}$ INPUT NOT NECESSARY WHEN AUXIND = 1,3

NOTES:
a. INPUT NOT NECESSARY WHEN CNFIND = 2
b. INPUT NOT NECESSARY WHEN CNFIND = 1
c. INPUT NOT NECESSARY WHEN DRGIND = 1
d. INPUT NOT NECESSARY WHEN OSWIND = 1
e. IF OPTIND = 2,3; ΔFe IS INPUT AS TOTAL DRAG
f. INPUT NOT NECESSARY WHEN AUXIND = 1,3
g. IF DRGIND = 1, ALL LOCATIONS MUST BE INPUT

BOEING VERTOL COMPANY
A DIVISION OF BOEING COMPANY

SHEET NO. OF	CASE NO.

HELICOPTER WEIGHT INFORMATION

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

VARIABLE	LOC.	VALUE
† OWE	2601	
W_{FE}	2602	
W_{FUL}	2603	
†† W_{PL}	2604	

INCREMENTAL GROUP WTS. NOM = 0

VARIABLE	LOC.	VALUE
ΔW_{FC}	2605	
ΔW_P	2606	
ΔW_{ST}	2607	

VARIABLE	LOC.	VALUE
RM_1	2608	
W_i	2609	
W_0	2610	
d_i	2611	
d_0	2612	

GROUP WEIGHT INFORMATION

FLIGHT CONTROLS

k_{CC}	2613	
k_{RC}	2614	
k_{SC}	2615	
k_{FW}	2616	
k_{TM}	2617	
k_{SAS}	2618	
k_{RCA}	2619	
k_{SCA}	2620	
k_{MC}	2621	

†OWE IS NOT NECESSARY WHEN OPTIND = 1,2

††W_{PL} IS NOT NECESSARY WHEN OPTIND = 2

STRUCTURAL

k_B	2622	
ΔC.G.	2623	
k_{LG}	2624	
k_{MG}	2625	
k_{WW}	2626	
LF	2627	
k_{WS}	2628	
k_{WP}	2629	
k_{HT}	2630	
k_{CLF}	2631	
k_{NAC}	2632	
k_{AIP}	2633	
k_{NACA}	2634	
k_{AIA}	2635	
k_{NS}	2636	

PROPULSION

k_{PRB}	2637	
k_{RBF}	2638	
k_{PH}	2639	
k_{amd}	2640	
k_{BLFD}	2641	
k_{TR}	2642	
k_{AR}	2643	
k_{PA}	2644	
k_{VTAR}	2645	
k_{PDS}	2646	
k_{PDSZ}	2647	
k_{TRDS}	2648	
k_{ADS}	2649	
k_{ADSZ}	2650	
k_{FS}	2651	
k_{PEI}	2652	
k_{AEI}	2653	

MULTIPLICATIVE FACTORS NOMINALLY = 1.0

K_1	2654	
K_2	2655	
K_3	2656	
K_4	2657	
K_5	2658	

K_6	2659	
K_7	2660	
K_8	2661	
K_9	2662	
K_{10}	2663	
K_{11}	2664	

K_{12}	2665	
K_{13}	2666	
K_{14}	2667	
K_{15}	2668	
K_{16}	2669	
K_{17}	2670	
K_{18}	2671	
K_{19}	2672	
K_{20}	2673	

FORM 63114 (11/73)

WEIGHT-BALANCE INFORMATION (REQUIRED ONLY WHEN MRPIND > 0)

NOTE	VARIABLE	LOC.	VALUE
	(X_{CGF}/l_B)	2678	
	ΔCG_R	2679	
	(X_{NG}/l_B)	2680	
	(X_{MG}/l_B)	2681	
	(X_{PE}/l_B)	2682	
	$(X_{PDS}/\Delta X_{PDS})$	2683	
	(X_{AV}/l_B)	2684	

NOTE	VARIABLE	LOC.	VALUE
	(X_{FURN}/l_B)	2685	
	(X_{APU}/l_B)	2686	
b.	(X_{AE}/l_B)	2687	
c.	$(X_{ADS}/\Delta X_{ADS})$	2688	
a.	(X_{AR}/l_{TB})	2689	
	(X_{SC}/l_B)	2690	
	(X_{ASC}/l_B)	2691	

NOTE	VARIABLE	LOC.	VALUE
	W_{AV}	2692	
	W_{FURN}	2693	
	W_{APU}	2694	
	K_{FULS}	2695	
	K_{TBBS}	2696	

NOTES: WHEN MRPIND EQUALS

1.0 ~ PROGRAM CALCULATES MAIN ROTOR POSITIONS BASED ON SIMPLE MASS BALANCE

2.0 ~ SAME AS 1, EXCEPT FOR COMPOUND HELICOPTER, THE AUX DRIVE SYSTEM, PROPELLER AND AUX INDEPENDENT ENGINES ARE ASSUMED TO BE LOCATED ON THE WING.

a) INPUT ONLYIF AUXIND > 2.0

b) INPUT ONLY IF AUXIND > 2, AIPIND = 2

c) INPUT ONLY IF AUXIND > 2, AIPIND = 1

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

ROTOR LIMITS INFORMATION

	LOC	VALUE
NUMBER OF C_X/σ	0347	
NUMBER OF μ	0348	

VALUES OF C_X/σ		
$(C_X/\sigma)_1$	0349	
$(C_X/\sigma)_2$	0350	
$(C_X/\sigma)_3$	0351	
$(C_X/\sigma)_4$	0352	
$(C_X/\sigma)_5$	0353	

VALUES OF μ		
μ_1	0354	
μ_2	0355	
μ_3	0356	
μ_4	0357	
μ_5	0358	
μ_6	0359	
μ_7	0360	

NOTE: ALL TABLES MUST BE AT LEAST 3 X 3 OR GREATER INPUT C_X/σ AND μ IN ASCENDING ORDER

VALUES OF C_T'/σ

	$(C_X/\sigma)_1$ =		$(C_X/\sigma)_2$ =		$(C_X/\sigma)_3$ =		$(C_X/\sigma)_4$ =		$(C_X/\sigma)_5$ =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
μ_1 =	0361		0368		0375		0382		0389	
μ_2 =	0362		0369		0376		0383		0390	
μ_3 =	0363		0370		0377		0384		0391	
μ_4 =	0364		0371		0378		0385		0392	
μ_5 =	0365		0372		0379		0386		0393	
μ_6 =	0366		0373		0380		0387		0394	
μ_7 =	0367		0374		0381		0388		0395	

FORM 53123 (8/79)

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

NONSTANDARD ATMOSPHERE INFORMATION

NO. OF PAIRS	1650	

NOTE: THIS TABLE IS NOT NECESSARY IF ATMIND IS NEVER SET TO 2

h_1	1651		θ_1	1661	
h_2	1652		θ_2	1662	
h_3	1653		θ_3	1663	
h_4	1654		θ_4	1664	
h_5	1655		θ_5	1665	
h_6	1656		θ_6	1666	
h_7	1657		θ_7	1667	
h_8	1658		θ_8	1668	
h_9	1659		θ_9	1669	
h_{10}	1660		θ_{10}	1670	

TAXI INFORMATION

SGTIND = 1

	ATMIND		ΔT_{IN} (°F) (NOTE a)		$(N_{II}/N_{II\,MAX})$ (PRIM ENG)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	0401		0421		0441	
2nd	0402		0422		0442	
3rd	0403		0423		0443	
4th	0404		0424		0444	
5th	0405		0425		0445	
6th	0406		0426		0446	
7th	0407		0427		0447	
8th	0408		0428		0448	
9th	0409		0429		0449	
10th	0410		0430		0450	

0 = STD ATMOSPHERE
1 = STD + ΔT_{IN}
2 = ARBITRARY θ (h)

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

	t_T (HR)		K_{FI} (NOTE b)	
	LOC	VALUE	LOC	VALUE
1st	0411		0431	
2nd	0412		0432	
3rd	0413		0433	
4th	0414		0434	
5th	0415		0435	
6th	0416		0436	
7th	0417		0437	
8th	0418		0438	
9th	0419		0439	
10th	0420		0440	

NOTE: a. INPUT NOT NECESSARY WHEN ATMIND = 0, 2
b. INPUT NOT NECESSARY WHEN AIPIND = 1.

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

TAKEOFF, HOVER, AND LANDING INFORMATION (SGTIND = 2)

	TOLIND LOC	TOLIND VALUE	ATMIND LOC	ATMIND VALUE	ΔT_{IN} (°F) (NOTE a) LOC	ΔT_{IN} (°F) (NOTE a) VALUE	T/W (NOTE b) LOC	T/W (NOTE b) VALUE	$(N_{II}/N_{II_{MAX}})$ (PRIMARY ENG) LOC	$(N_{II}/N_{II_{MAX}})$ (PRIMARY ENG) VALUE
1st	0461		0481		0501		0521		0541	
2nd	0462		0482		0502		0522		0542	
3rd	0463		0483		0503		0523		0543	
4th	0464		0484		0504		0524		0544	
5th	0465		0485		0505		0525		0545	
6th	0466		0486		0506		0526		0546	
7th	0467		0487		0507		0527		0547	
8th	0468		0488		0508		0528		0548	
9th	0469		0489		0509		0529		0549	
10th	0470		0490		0510		0530		0550	

TOLIND:
1 = INPUT T/W, $V_{R/C}$
2 = INPUT PEHF, $V_{R/C}$
3 = INPUT T/W, $V_{R/C}$, h_{BF}/D
4 = INPUT PEHF, $V_{R/C}$, h_{BF}/D

ATMIND:
0 = STANDARD ATMOSPHERE
1 = STD + ΔT_{IN}
2 = ARBITRARY θ (h)

	h_{BF}/D (NOTE c) LOC	h_{BF}/D (NOTE c) VALUE	PEHF (NOTE d) LOC	PEHF (NOTE d) VALUE	$V_{R/C}$ (FPM) LOC	$V_{R/C}$ (FPM) VALUE	Δt_H (HR) LOC	Δt_H (HR) VALUE	t_H (HR) LOC	t_H (HR) VALUE
1st	0471		0491		0511		0531		0551	
2nd	0472		0492		0512		0532		0552	
3rd	0473		0493		0513		0533		0553	
4th	0474		0494		0514		0534		0554	
5th	0475		0495		0515		0535		0555	
6th	0476		0496		0516		0536		0556	
7th	0477		0497		0517		0537		0557	
8th	0478		0498		0518		0538		0558	
9th	0479		0499		0519		0539		0559	
10th	0480		0500		0520		0540		0560	

NOTES:
a. INPUT NOT NECESSARY WHEN ATMIND = 0, 2
b. INPUT NOT NECESSARY WHEN TOLIND = 2, 4
c. INPUT NOT NECESSARY WHEN TOLIND = 1, 2
d. INPUT NOT NECESSARY WHEN TOLIND = 1, 3

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

FORM 53126 (6/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

CLIMB INFORMATION (SGTIND = 3)

	CLMIND		ATMIND		ΔT_{in} (°F) (NOTE a)		POWIND		$N_{II}/N_{II\,MAX}$ (PRIMARY ENG)		$N_{II}/N_{II\,MAX}$ (AUX ENG) (NOTE e)		T_{AUX}/T_{TOT} (NOTE b)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	[illegible]		0591		0611		0631		0651		0671		0691	
2nd	[illegible]		[illegible]		0612		0632		0652		0672		[illegible]	
3rd	[illegible]		[illegible]		0613		0633		0653		0673		[illegible]	
4th	[illegible]		[illegible]		0614		0634		0654		0674		[illegible]	
5th	[illegible]		0595		0615		0635		0655		0675		[illegible]	
6th	[illegible]		[illegible]		0616		0636		0656		0676		[illegible]	
7th	0577		0597		0617		0637		0657		0677		0697	
8th	[illegible]		[illegible]		0618		0638		0658		0678		[illegible]	
9th	[illegible]		[illegible]		0619		0639		0659		0679		[illegible]	
10th	[illegible]		[illegible]		0620		0640		0660		0680		0700	

CLMIND:
1 = MAX R/C
2 = CONSTANT EAS
3 = CONSTANT MACH
4 = CONSTANT TAS

ATMIND:
0 = STANDARD ATMOSPHERE
1 = STD + ΔT_{IN}
2 = ARBITRARY θ (h)

POWIND:
0 = MAX POWER
1 = MIL POWER
2 = NORMAL POWER

	MACH OR EAS OR TAS (NOTE c)		$C_{L_{WING}}$ (NOTE d)		Δh (FT)		h_{MAX} (FT)		ΔFe_{CL} (FT²)		$N_{PSD_{CL}}$		$N_{PSD\,i_{CL}}$ (NOTE e)	
		VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE		VALUE	LOC	VALUE	LOC	VALUE
1st	[illegible]		0601		0621		0641		0661		0681		0701	
2nd	[illegible]		0602		0622		0642		0662		0682		0702	
3rd	[illegible]		0603		0623		0643		0663		0683		0703	
4th	[illegible]		0604		0624		0644		0664		0684		0704	
5th	[illegible]		0605		0625		0645		0665		0685		0705	
6th	[illegible]		0606		0626		0646		0666		0686		0706	
7th	[illegible]		0607		0627		0647		0667		0687		0707	
8th	[illegible]		0608		0628		0648		0668		0688		0708	
9th	[illegible]		0609		0629		0649		0669		0689		0709	
10th	[illegible]		0610		0630		0650		0670		0690		0710	

NOTES:
a. INPUT NOT NECESSARY WHEN ATMIND = 0, 2
b. INPUT NOT NECESSARY WHEN AUXIND = 1, 2
c. INPUT NOT NECESSARY WHEN CLMIND = 1
d. INPUT NOT NECESSARY WHEN AUXIND = 1, 3
e. INPUT NOT REQUIRED WHEN AIPIND = 1.

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO. OF	CASE NO.

CRUISE INFORMATION (SGTIND = 4)

	CRSIND		ATMIND		ΔT_{IN} (°F) (NOTE a)		POWIND (NOTE b)		$N_{II}/N_{II\,MAX}$ (PRIMARY ENG)		$N_{II}/N_{II\,MAX}$ (AUX ENG) (NOTE f)		T_{AUX}/T_{TOT} (NOTE c)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	0721		0741		0761		0781		0801		0821		0841	
2nd	0722		0742		0762		0782		0802		0822		0842	
3rd	0723		0743		0763		0783		0803		0823		0843	
4th	0724		0744		0764		0784		0804		0824		0844	
5th	0725		0745		0765		0785		0805		0825		0845	
6th	0726		0746		0766		0786		0806		0826		0846	
7th	0727		0747		0767		0787		0807		0827		0847	
8th	0728		0748		0768		0788		0808		0828		0848	
9th	0729		0749		0769		0789		0809		0829		0849	
10th	0730		0750		0770		0790		0810		0830		0850	

CRSIND:
1 = SPECIFIED POWER
2 = CONSTANT TAS
3 = BEST NMPP
4 = 99% BEST NMPP
5 = BEST NMPP, CONST. W/δ
6 = 99% BEST NMPP, CONST W/δ

ATMIND:
0 = STANDARD ATMOSPHERE
1 = STD + ΔT_{IN}
2 = ARBITRARY θ (h)

POWIND:
0 = MAX POWER
1 = MIL POWER
2 = NORMAL POWER

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

	V_{IN} OR HEADWIND (KTS) (NOTE d)		$C_{L_{WING}}$ (NOTE e)		ΔR(NM)		R_{MAX}(NM)		ΔFe_{CR} (FT^2)		$N_{PSD_{CR}}$		$N_{PSD\,i_{CR}}$ (NOTE f)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	[illegible]		0751		0771		0791		0811		0831		0851	
2nd	[illegible]		0752		0772		0792		0812		0832		0852	
3rd	[illegible]		0753		0773		0793		0813		0833		0853	
4th	[illegible]		0754		0774		0794		0814		0834		0854	
5th	[illegible]		[illegible]		0775		0795		0815		0835		0855	
6th	[illegible]		[illegible]		0776		0796		0816		0836		0856	
7th	[illegible]		0757		0777		0797		0817		0837		0857	
8th	[illegible]		[illegible]		0778		[illegible]		0818		0838		[illegible]	
9th	[illegible]		[illegible]		0779		[illegible]		0819		[illegible]		[illegible]	
10th	[illegible]		[illegible]		0780		[illegible]		0820		0840		[illegible]	

NOTES:
a. INPUT NOT NECESSARY WHEN ATMIND = 0, 2
b. INPUT NOT NECESSARY WHEN CRSIND = 3
c. INPUT NOT NECESSARY WHEN AUXIND = 1, 2
d. NOT REQUIRED WHEN CRSIND = 1
INPUT V_{IN} WHEN CRSIND = 2
INPUT HEADWIND WHEN CRSIND = 3 THRU 6
e. INPUT NOT NECESSARY WHEN AUXIND = 1, 3
f. INPUT NOT NECESSARY WHEN AIPIND = 1

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO:	CASE NO.
OF	

DESCENT INFORMATION (SGTIND = 5)

	DESIND		RMAXIND		ATMIND		ΔT_{IN} (°F) (NOTE a)		R/D (FPM)		$N_{II}/N_{II\,MAX}$ (PRIMARY ENG)		$N_{II}/N_{II\,MAX}$ (AUX ENG) (NOTE d)		T_{AUX}/T_{TOT} (NOTE b)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1ST	[illegible]		0881		0911		0931		0961		0971		0991		1011	
2ND	[illegible]		0882		0912		0932		0962		0972		0992		1012	
3RD	0873		0883		0913		0933		0963		0973		0993		1013	
4TH	0874		0884		0914		0934		0964		0974		0994		1014	
5TH	0875		0885		0915		0935		0965		0975		0995		1015	
6TH	0876		0886		0916		0936		0966		0976		0996		1016	
7TH	0877		0887		0917		0937		0967		0977		0997		1017	
8TH	[illegible]		[illegible]		0918		0938		0968		0978		0998		1018	
9TH	[illegible]		[illegible]		0919		0939		0969		0979		0999		1019	
10TH	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		1000		1020	

1 = CONSTANT TAS
2 = CONSTANT EAS
3 = CONSTANT MACH NO.

0 = TERMINAL RANGE SPECIFIED
1 = TERM. RANGE CHK'D, BUT NOT MATCHED
2 = DESCENT TO SPECIFIED MIN ALT.
3 = SPIRAL DESCENT PATH

0 = STD ATMOSPHERE
1 = STD + ΔT_{IN}
2 = ARBITRARY $\theta(h)$

	MACH OR EAS OR TAS (KTS)		C_{L_W} (NOTE c)		Δh (FT)		h_{MIN} (FT)		R_{MAX} (NM)		ΔFe_{DSC} (FT²)		$N_{PSD_{DSC}}$		$N_{PSD_{i_{DSC}}}$ (NOTE d)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1ST	[illegible]		[illegible]		[illegible]		0941		0951		0901		1001		[illegible]	
2ND	[illegible]		[illegible]		[illegible]		0942		[illegible]		0902		1002		[illegible]	
3RD	[illegible]		[illegible]		[illegible]		0943		[illegible]		0903		[illegible]		[illegible]	
4TH	[illegible]		[illegible]		[illegible]		0944		[illegible]		0904		[illegible]		[illegible]	
5TH	[illegible]		[illegible]		[illegible]		0945		[illegible]		[illegible]		[illegible]		[illegible]	
6TH	[illegible]		[illegible]		[illegible]		0946		[illegible]		[illegible]		[illegible]		[illegible]	
7TH	[illegible]		[illegible]		[illegible]		0947		0957		0907		1007		[illegible]	
8TH	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
9TH	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
10TH	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	

NOTES: a. INPUT NOT NECESSARY WHEN ATMIND = 0, 2
b. INPUT NOT NECESSARY WHEN AUXIND = 1, 2
c. INPUT NOT NECESSARY WHEN AUXIND = 1, 3

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

LOITER INFORMATION (SGTIND = 6)

	ATMIND		ΔT_{IN} (°F) (NOTE a)		$(N_{II}/N_{II\,MAX})$ (PRIMARY ENG)		$(N_{II}/N_{II\,MAX})$ (AUX ENG) (NOTE d)		T_{AUX}/T_{TOT} (NOTE b)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	1031		1051		1071		1091		1111	
2nd	1032		1052		1072		1092		1112	
3rd	1033		1053		1073		1093		1113	
4th	1034		1054		1074		1094		1114	
5th	1035		1055		1075		1095		1115	
6th	1036		1056		1076		1096		1116	
7th	1037		1057		1077		1097		1117	
8th	1038		1058		1078		1098		1118	
9th	1039		1059		1079		1099		1119	
10th	1040		1060		1080		1100		1120	

0 = STANDARD ATMOSPHERE
1 = STD + ΔT_{IN}
2 = ARBITRARY θ (h)

	C_{L_W} (NOTE c)		Δt_L (HR)		t_L (HR)		N_{PSD} LOITER		$N_{PSD\,i}$ LOITER (NOTE d)		ΔFe_L (FT²)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	1041		1061		1081		1101		1121		1131	
2nd	1042		1062		1082		1102		1122		1132	
3rd	1043		1063		1083		1103		1123		1133	
4th	1044		1064		1084		1104		1124		1134	
5th	1045		1065		1085		1105		1125		1135	
6th	1046		1066		1086		1106		1126		1136	
7th	1047		1067		1087		1107		1127		1137	
8th	1048		1068		1088		1108		1128		1138	
9th	1049		1069		1089		1109		1129		1139	
10th	1050		1070		1090		1110		1130		1140	

NOTES:
a. INPUT NOT NECESSARY WHEN ATMIND = 0, 2
b. INPUT NOT NECESSARY WHEN AUXIND = 1, 2
c. INPUT NOT NECESSARY WHEN AUXIND = 1, 3
d. INPUT NOT NECESSARY WHEN AIPIND = 1.

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

FORM 83130(8/79)

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

CHANGE IN FUEL WEIGHT (SGTIND = 7)

ΔW_F (LBS)

	LOC	VALUE
1st	1141	
2nd	1142	
3rd	1143	
4th	1144	
5th	1145	
6th	1146	
7th	[illegible]	
8th	[illegible]	
9th	[illegible]	
10th	[illegible]	

t_{FW} (HR)

	LOC	VALUE
1st	1151	
2nd	1152	
3rd	1153	
4th	1154	
5th	1155	
6th	1156	
7th	1157	
8th	1158	
9th	1159	
10th	1160	

CHANGE IN PAYLOAD WEIGHT (SGTIND = 8)

ΔW_{PL} (LBS)

	LOC	VALUE
1st	1161	
2nd	1162	
3rd	1163	
4th	1164	
5th	1165	
6th	1166	
7th	1167	
8th	1168	
9th	1169	
10th	1170	

t_{PW} (HR)

	LOC	VALUE
1st	1171	
2nd	1172	
3rd	1173	
4th	1174	
5th	1175	
6th	1176	
7th	1177	
8th	1178	
9th	1179	
10th	1180	

TRANSFER ALTITUDE (SGTIND = 9)

h_{FINAL} (FT) (h_{OPT}IND = 0)

OR h_{MAX} (FT) (h_{OPT}IND = 1)

	LOC	VALUE
1st	[illegible]	
2nd	[illegible]	
3rd	[illegible]	
4th	[illegible]	
5th	[illegible]	
6th	[illegible]	
7th	[illegible]	
8th	[illegible]	
9th	[illegible]	
10th	[illegible]	

CHANGE FUEL OR CHANGE PAYLOAD

OR SGTIND = 7
SGTIND = 8

WGTIND

LOC	VALUE
[illegible]	

0 = $W + \Delta W \leq W_G$

1 = NO WEIGHT RESTRICTION

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO. OF	CASE NO.

GENERAL PERFORMANCE INFORMATION (SGTIND = 11)

	GWIND		ATMIND		ΔT_{IN}(°F) (NOTE a)		ALTITUDE (FT)		N_{II}/N_{II} MAX (PRIMARY ENG)		N_{II}/N_{II} MAX (AUX ENG) (NOTE e)		T_{AUX}/T_{TOT} (NOTE b)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	4140		4160		4180		4200		4220		4240		4260	
2nd	4141		4161		4181		4201		4221		4241		4261	
3rd	4142		4162		4182		4202		4222		4242		4262	
4th	4143		4163		4183		4203		4223		4243		4263	
5th	4144		4164		4184		4204		4224		4244		4264	
6th	4145		4165		4185		4205		4225		4245		4265	
7th	4146		4166		4186		4206		4226		4246		4266	
8th	4147		4167		4187		4207		4227		4247		4267	
9th	4148		4168		4188		4208		4228		4248		4268	
10th	4149		4169		4189		4209		4229		4249		4269	

GWIND: 1 = ΔGW INPUT; 2 = GW INPUT

ATMIND: 0 = STANDARD ATMOSPHERE; 1 = STD + ΔT_{IN}; 2 = ARBITRARY $\theta_{(h)}$

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

	GW OR ΔGW (LB) (NOTE c)		$C_{L_{WING}}$ (NOTE d)		ΔFe_{CR} (FT^2)		T/W		ΔV (KTS)		V_{MAX} (KTS)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	4150		4170		4190		4210		4230		4250	
2nd	4151		4171		4191		4211		4231		4251	
3rd	4152		4172		4192		4212		4232		4252	
4th	4153		4173		4193		4213		4233		4253	
5th	4154		4174		4194		4214		4234		4254	
6th	4155		4175		4195		4215		4235		4255	
7th	4156		4176		4196		4216		4236		4256	
8th	4157		4177		4197		4217		4237		4257	
9th	4158		4178		4198		4218		4238		4258	
10th	4159		4179		4199		4219		4239		4259	

NOTES:
a. INPUT NOT NECESSARY WHEN ATMIND = 0, 2
b. INPUT NOT NECESSARY WHEN AUXIND = 1, 2
c. INPUT ΔGW WHEN GWIND = 1; INPUT GW WHEN GWIND = 2
d. INPUT NOT NECESSARY WHEN AUXIND = 1, 3
e. INPUT NOT NECESSARY WHEN AIPIND = 1

ROTOR TIP SPEED OR MACH NUMBER SCHEDULE

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

	LOC	VALUE
NO. OF PAIRS IN V_{TIP}/M_{T90} TABLE	1258	

	LOC	VALUE		LOC	VALUE
VALUES OF M	1259		VALUES OF $V_{TIP_{REF}}$ OR $M_{T90_{REF}}$	1269	
	1260			1270	
	1261			1271	
	1262			1272	
	1263			1273	
	1264			1274	
	12			1275	
	1266			1276	
	1267			1277	
	1268			1278	

NOTES:
1. IF $N_{II}/N_{II\,MAX} < 10$, PROGRAM USES ACTUAL VALUE OF $N_{II}/N_{II\,MAX}$.
2. IF $10 < N_{II}/N_{II\,MAX} < 20$, PROGRAM ASSUMES V_{TIP} SCHEDULE IS MIX OF $M_{ADV_{TIP}}$ AND V_{TIP}.
3. IF $N_{II}/N_{II\,MAX} > 20$, PROGRAM ASSUMES V_{TIP} SCHEDULE IS IN V_{TIP} ONLY.

AUXILIARY PROPULSION SCHEDULE (T_{AUX}/T)

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

	LOC	VALUE
NO. OF PAIRS IN T_{AUX}/T TABLE	1671	

	LOC	VALUE		LOC	VALUE
VALUES OF μ	1672		VALUES OF T_{AUX}/T	1682	
	1673			1683	
	1674			1684	
	1675			1685	
	1676			1686	
	1677			1687	
	1678			1688	
	1679			1689	
	1680			1690	
	1681			1691	

	LOC	VALUE
T_{AUX}/T SCHEDULE μ LIMIT	1692	

NOTES:
1. IF $T_{AUX}/T < 1000$, INPUT T_{AUX}/T IS USED
2. IF $T_{AUX}/T = 1000$, INPUT SCHEDULE IS USED
3. IF $T_{AUX}/T = 2000$, INPUT SCHEDULE IS USED UP TO TRANSITION μ INDICATED BY LOC 1692. ABOVE THAT μ THE T_{AUX}/T CORRESPONDING TO MAX ROTOR OR CONFIGURATION L/D_E IS USED. USE THIS OPTION ONLY WITH ROTIND > 4, AUXIND > 2.

SHEET NO.	CASE NO.
OF	

ENGINE CYCLE DATA; NON-STANDARD PERFORMANCE

PRIMARY ENGINE DATA

VARIABLE	LOC	VALUE
WDTIND	1201	
N1IND	1202	
N1θIND	1203	
N2IND	1204	
QIND	1205	

VARIABLE	LOC	VALUE	
$\dot{W}_{MAX}/\dot{W}^*$	1220		INPUT IF WDTIND = 1
$N_{I\,MAX}/N_I^*$	1221		INPUT IF N1IND = 1
$(N_I/\sqrt{\theta_1}/N_I^*)_{MAX}$	1222		INPUT IF N1θIND = 1
$N_{II\,MAX}/N_{II}^*$	1223		INPUT IF N2IND = 1,2
Q_{MAX}/Q^*	1224		INPUT IF QIND = 1,2

WDTIND: 0 = NO FUEL FLOW CUTOFF; 1 = FUEL FLOW CUTOFF

N1IND: 0 = NO N1 CUTOFF; 1 = N1 CUTOFF

N2IND: 0 = NO N2 CUTOFF; OPTIMUM N2 VARIATION; 1 = N2 CUTOFF; OPTIMUM N2 VARIATION; 2 = N2 CUTOFF; NON-OPTIMUM N2 VARIATION

QIND: 0 = NO TORQUE LIMIT; 1 = TORQUE LIMIT IMPOSED ON MAIN AND TAIL ROTOR XMSN; 2 = TORQUE LIMIT IMPOSED ON AUX PROPULSION XMSN

N1θIND: 0 = NO REFERRED N1 CUTOFF; 1 = REFERRED N1 CUTOFF

NOTE: QIND = 2 IS USED ONLY WITH AUXIND > 2.0, η_PIND = 0 AND AIPIND = 1

WHEN OPTIND = 2 OR 3, CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

VARIABLE	LOC	VALUE
RNOIND	1206	

0= NO REYNOLDS NO. CORRECTIONS
1= REYNOLDS NO. CORRECTIONS

REYNOLDS NO. CORRECTION FACTOR

VALUES OF $\frac{N_I}{N_I^*} \frac{D}{\nu_1}$

LOC	VALUE
1207	
1208	
1209	
1210	
1211	
1212	
1213	
1214	
1215	
1216	

VALUES OF K_{PR}

LOC	VALUE
1225	
1226	
1227	
1228	
1229	
1230	
1231	
1232	
1233	
1234	

INPUT THIS TABLE IF RNOIND = 1

OUTPUT SHAFT SPEED CORRECTION

VALUES OF $\frac{N_{II}}{N_{II\,OPT}}$

LOC	VALUE
1238	
1239	
1240	
1241	
1242	
1243	
1244	
1245	
1246	
1247	

VALUES OF K_{PN}

LOC	VALUE
1248	
1249	
1250	
1251	
1252	
1253	
1254	
1255	
1256	
1257	

INPUT THIS TABLE IF N2IND = 2 AND NON-STANDARD CORRECTION IS DESIRED

ENGINE CYCLE DATA; NON-STANDARD PERFORMANCE

AUXILIARY INDEPENDENT ENGINE DATA

VARIABLE	LOC	VALUE	VARIABLE	LOC	VALUE	
WDTINDI	2201		$\dot{W}_{MAX}/\dot{W}^*$	2220		INPUT IF WDTINDI = 1
N1INDI	2202		N_{IMAX}/N_1^*	2221		INPUT IF N1INDI = 1
N1θINDI	2203		$(N_1/\sqrt{\theta_1}/N_1^*)$ MAX	2222		INPUT IF N1θINDI = 1
N2INDI	2204		$N_{II\,MAX}/N_{II}^*$	2223		INPUT IF N2INDI = 1, 2
QINDI	2205		Q_{MAX}/Q^*	2224		INPUT IF QINDI = 1

WDTINDI: { 0 = NO FUEL FLOW CUTOFF; 1 = FUEL FLOW CUTOFF

N2INDI: { 0 = NO N2 CUTOFF; OPTIMUM N2 VARIATION; 1 = N2 CUTOFF; OPTIMUM N2 VARIATION; 2 = N2 CUTOFF; NON-OPTIMUM N2 VARIATION

N1INDI: { 0 = NO N1 CUTOFF; 1 = N1 CUTOFF

QINDI: { 0 = NO TORQUE CUTOFF; 1 = TORQUE CUTOFF

N1θINDI: { 0 = NO REFERRED N1 CUTOFF; 1 = REFERRED N1 CUTOFF

VARIABLE	LOC	VALUE
RNOINDI	2206	

0 = NO REYNOLDS NO. CORRECTIONS
1 = REYNOLDS NO. CORRECTIONS

REYNOLDS NO. CORRECTION FACTOR

VALUES OF $\frac{N_I}{N_{I^*}}$ $\frac{D}{\nu_1}$

LOC	VALUE
2207	
2208	
2209	
2210	
2211	
2212	
2213	
2214	
2215	
2216	

VALUES OF K_{PR}

LOC	VALUE
2225	
2226	
2227	
2228	
2229	
2230	
2231	
2232	
2233	
2234	

INPUT THIS TABLE IF RNOINDI = 1

OUTPUT SHAFT SPEED CORRECTION

VALUES OF $\frac{N_{II}}{N_{II\,OPT}}$

LOC	VALUE
2238	
2239	
2240	
2241	
2242	
2243	
2244	
2245	
2246	
2247	

VALUES OF K_{PN}

LOC	VALUE
2248	
2249	
2250	
2251	
2252	
2253	
2254	
2255	
2256	
2257	

INPUT THIS TABLE IF N2INDI = 2 AND NON-STANDARD CORRECTION IS DESIRED

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

PRIMARY ENGINE CYCLE INFORMATION (Sheet 1)

THESE TABLES NOT REQUIRED WHEN STANDARD CYCLE IS SELECTED.

VARIABLE	LOC	VALUE
CYCLE NO.	1301	
k_3	1302	
k_4	1303	

k_3, k_4: NOTE a.

VARIABLE	LOC	VALUE
ξ_4	1304	
T_{GI} (°R)	1305	
T_{FI} (°R)	1306	

ξ_4: NOTE b.

VARIABLE	LOC	VALUE
T_{NP} (°R)	1307	
T_{MIL} (°R)	1308	
T_{MAX} (°R)	1309	

ALL TABLES MUST BE AT LEAST 3 x 3 IN SIZE

NO. OF T/θ	LOC 1310	VALUE

VALUES OF T/θ

	LOC	VALUE
1	1311	
2	1312	
3	1313	
4	1314	
5	1315	
6	1316	
7	1317	
8	1318	

NO. OF M	LOC 1319	VALUE

VALUES OF M

	LOC	VALUE
M_1	1320	
M_2	1321	
M_3	1322	
M_4	1323	
M_5	1324	
M_6	1325	

VALUES OF REFERRED THRUST OR HORSEPOWER ($F_N/\delta F_N^*$ OR $SHP/\delta\sqrt{\theta}\,SHP^*$)

	$(T/\theta)_1=$		$(T/\theta)_2=$		$(T/\theta)_3=$		$(T/\theta)_4=$		$(T/\theta)_5=$		$(T/\theta)_6=$		$(T/\theta)_7=$		$(T/\theta)_8=$	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
M_1	1326		1332		1338		1344		1350		1356		1362		1368	
M_2	1327		1333		1339		1345		1351		1357		1363		1369	
M_3	1328		1334		1340		1346		1352		1358		1364		1370	
M_4	1329		1335		1341		1347		1353		1359		1365		1371	
M_5	1330		1336		1342		1348		1354		1360		1366		1372	
M_6	1331		1337		1343		1349		1355		1361		1367		1373	

NOTE: WHEN USING AUXILIARY ENGINES, AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE.

NO. OF T/θ	LOC 1374	VALUE

VALUES OF T/θ

	LOC	VALUE
1	1375	
2	1376	
3	1377	
4	1378	
5	1379	
6	1380	
7	1381	
8	1382	

NO. OF M	LOC 1383	VALUE

VALUES OF M

	LOC	VALUE
M_1	1384	
M_2	1385	
M_3	1386	
M_4	1387	
M_5	1388	
M_6	1389	

VALUES OF REFERRED FUEL FLOW ($\omega_f/\delta\sqrt{\theta}\,F_N^*$ OR $\omega_f/\delta\sqrt{\theta}\,SHP^*$)

	$(T/\theta)_1=$		$(T/\theta)_2=$		$(T/\theta)_3=$		$(T/\theta)_4=$		$(T/\theta)_5=$		$(T/\theta)_6=$		$(T/\theta)_7=$		$(T/\theta)_8=$	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
M_1	1390		1396		1402		1408		1414		1420		1426		1432	
M_2	1391		1397		1403		1409		1415		1421		1427		1433	
M_3	1392		1398		1404		1410		1416		1422		1428		1434	
M_4	1393		1399		1405		1411		1417		1423		1429		1435	
M_5	1394		1400		1406		1412		1418		1424		1430		1436	
M_6	1395		1401		1407		1413		1419		1425		1431		1437	

NOTE a. k_4 IN LBS; IF ENGIND = 0, k_3 IS IN LB/HP; IF ENGIND = 1,2, k_3 IS IN LB/LB THRUST

b. IF ENGIND = 0, ξ_4 IS IN FT/SHP$^{\frac{1}{2}}$; IF ENGIND = 1,2, ξ_4 IS IN FT/LB THRUST$^{\frac{1}{2}}$

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

PRIMARY ENGINE CYCLE INFORMATION (Sheet 2)

NO.	LOC	VALUE
T/θ	[illegible]	

NO.	LOC	VALUE
M	1447	

VALUES OF T/θ		
	LOC	VALUE
1	1439	
2	1440	
3	1441	
4	1442	
5	1443	
6	1444	
7	1445	
8	1446	

VALUES OF M		
	LOC	VALUE
M_1	1448	
M_2	1449	
M_3	1450	
M_4	1451	
M_5	1452	
M_6	1453	

VALUES OF REFERRED N_I $(N_I/\sqrt{\theta}N_I^*)$

	$(T/\theta)_1$=		$(T/\theta)_2$=		$(T/\theta)_3$=		$(T/\theta)_4$=		$(T/\theta)_5$=		$(T/\theta)_6$=		$(T/\theta)_7$=		$(T/\theta)_8$=	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
M_1	1454		1460		1466		1472		1478		1484		1490		1496	
M_2	1455		1461		1467		1473		1479		1485		1491		1497	
M_3	1456		1462		1468		1474		1480		1486		1492		1498	
M_4	1457		1463		1469		1475		1481		1487		1493		1499	
M_5	1458		1464		1470		1476		1482		1488		1494		1500	
M_6	1459		1465		1471		1477		1483		1489		1495		1501	

NO.	LOC	VALUE
T/θ	1502	

NO.	LOC	VALUE
M	1511	

VALUES OF T/θ		
	LOC	VALUE
1	1503	
2	1504	
3	1505	
4	1506	
5	1507	
6	1508	
7	1509	
8	1510	

VALUES OF M		
	LOC	VALUE
M_1	1512	
M_2	1513	
M_3	1514	
M_4	1515	
M_5	1516	
M_6	1517	

VALUES OF REFERRED N_{II} $(N_{II}/\sqrt{\theta}N_{II}^*)$

	$(T/\theta)_1$=		$(T/\theta)_2$=		$(T/\theta)_3$=		$(T/\theta)_4$=		$(T/\theta)_5$=		$(T/\theta)_6$=		$(T/\theta)_7$=		$(T/\theta)_8$=	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
M_1	1518		1524		1530		1536		1542		1548		1554		1560	
M_2	1519		1525		1531		1537		1543		1549		1555		1561	
M_3	1520		1526		1532		1538		1544		1550		1556		1562	
M_4	1521		1527		1533		1539		1545		1551		1557		1563	
M_5	1522		1528		1534		1540		1546		1552		1558		1564	
M_6	1523		1529		1535		1541		1547		1553		1559		1565	

NOTE: WHEN USING AUXILIARY ENGINES, AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE.

FORM 80840 (8/79)

BOEING VERTOL COMPANY
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HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

SHORT FORM AERO (MAIN) ROTOR CYCLE INFORMATION

VARIABLE	LOC	VALUE
[illegible]	[illegible]	
[illegible]	[illegible]	

HOVER (STATIC THRUST DATA)

VARIABLE	LOC	VALUE
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	

CRUISE DATA

VARIABLE	LOC	VALUE
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	

NOTES: INPUT ONLY WHEN ROTIND = 1

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS.

NO. OF CT	LOC	VALUE
	1616	

HOVER (STATIC THRUST DATA)

	VALUES OF C_T		VALUES OF K_{HOV_A}	
	LOC	VALUE	LOC	VALUE
[illegible]	[illegible]		1627	
[illegible]	[illegible]		1628	
[illegible]	[illegible]		1629	
[illegible]	[illegible]		1630	
[illegible]	[illegible]		1631	
[illegible]	[illegible]		1632	
7	[illegible]		1633	
[illegible]	[illegible]		1634	
[illegible]	[illegible]		1635	
[illegible]	[illegible]		1636	

1637	

0 = USES SCHEDULED ROTOR PROPULSIVE EFFICIENCY
1 = USES 100% ROTOR PROPULSIVE EFFICIENCY

THIS INFORMATION IS FOR REFERENCE PURPOSES ONLY	
REFERENCE BLADE NO.	
BLADE PLANFORM TAPER RATIO $\lambda = C_{TIP}/C_{C.\ LINE\ ROT.}$	
BLADE AIRFOIL DISTRIBUTION	
RADIAL STA (r/R)	AIRFOIL DESIGNATION
REMARKS	

FORM 83122 (8/79)

ROTOR PERFORMANCE MAP
(ROTIND = 2,3)

	LOC	VALUE
ROTOR MAP NO.	2700	

	LOC	VALUE
b_{REF}	2701	
c_{REF}	2702	
$\theta_{T_{REF}}$	2703	

HOVER PERFORMANCE

	LOC	VALUE
NO. OF C_T/σ'S	2704	

	LOC	VALUE
NO. OF M_{TIP}'S	2715	

VALUES OF C_T/σ

	LOC	VALUE
$(C_T/\sigma)_1$	2705	
$(C_T/\sigma)_2$	2706	
$(C_T/\sigma)_3$	2707	
$(C_T/\sigma)_4$	2708	
$(C_T/\sigma)_5$	2709	
$(C_T/\sigma)_6$	2710	
$(C_T/\sigma)_7$	2711	
$(C_T/\sigma)_8$	2712	
$(C_T/\sigma)_9$	2713	
$(C_T/\sigma)_{10}$	2714	

VALUES OF M_{TIP}

	LOC	VALUE
M_{T_1}	2716	
M_{T_2}	2717	
M_{T_3}	2718	
M_{T_4}	2719	
M_{T_5}	2720	
M_{T_6}	2721	

$$C_T/\sigma = 4T/\rho \pi D^2 V_T^2 N_R \sigma$$

$$C_{P_H}/\sigma = 2200 \text{ RHP}/\rho \pi D^2 V_T^3 N_R \sigma$$

INPUT VALUES OF C_{P_H}/σ FOR COMBINATIONS OF C_T/σ AND M_{TIP}

	M_{TIP_1} =		M_{TIP_2} =		M_{TIP_3} =		M_{TIP_4} =		M_{TIP_5} =		M_{TIP_6} =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T/\sigma)_1$ =	2722		2732		2742		2752		2762		2772	
$(C_T/\sigma)_2$ =	2723		2733		2743		2753		2763		2773	
$(C_T/\sigma)_3$ =	2724		2734		2744		2754		2764		2774	
$(C_T/\sigma)_4$ =	2725		2735		2745		2755		2765		2775	
$(C_T/\sigma)_5$ =	2726		2736		2746		2756		2766		2776	
$(C_T/\sigma)_6$ =	2727		2737		2747		2757		2767		2777	
$(C_T/\sigma)_7$ =	2728		2738		2748		2758		2768		2778	
$(C_T/\sigma)_8$ =	2729		2739		2749		2759		2769		2779	
$(C_T/\sigma)_9$ =	2730		2740		2750		2760		2770		2780	
$(C_T/\sigma)_{10}$ =	2731		2741		2751		2761		2771		2781	

NOTES:
a. C_T & C_p ARE IN "ROTOR" NOTATION
b. WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS
c. ALL TABLES MUST BE COMPLETELY FILLED.

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO. 2 OF 5	CASE NO.

ROTOR PERFORMANCE "MAP"
(ROTIND = 2,3)

CRUISE PERFORMANCE

	LOC	VALUE
NO. OF ADVANCE RATIOS (μ)	2782	

	LOC	VALUE
NO. OF ROTOR LIFT COEFFICIENTS (C_T'/σ)	2789	

	LOC	VALUE
NO. OF ROTOR PROPULSIVE THRUST COEFF (C_X/σ)	2800	

VALUES OF μ

	LOC	VALUE
μ_1	2783	
μ_2	2784	
μ_3	2785	
μ_4	2786	
μ_5	2787	
μ_6	2788	

VALUES OF (C_T'/σ)

	LOC	VALUE
$(C_T'/\sigma)_1$	2790	
$(C_T'/\sigma)_2$	2791	
$(C_T'/\sigma)_3$	2792	
$(C_T'/\sigma)_4$	2793	
$(C_T'/\sigma)_5$	2794	
$(C_T'/\sigma)_6$	2795	
$(C_T'/\sigma)_7$	2796	
$(C_T'/\sigma)_8$	2797	
$(C_T'/\sigma)_9$	2798	
$(C_T'/\sigma)_{10}$	2799	

VALUES OF C_X/σ

	LOC	VALUE
$(C_X/\sigma)_1$	2801	
$(C_X/\sigma)_2$	2802	
$(C_X/\sigma)_3$	2803	
$(C_X/\sigma)_4$	2804	
$(C_X/\sigma)_5$	2805	
$(C_X/\sigma)_6$	2806	
$(C_X/\sigma)_7$	2807	
$(C_X/\sigma)_8$	2808	
$(C_X/\sigma)_9$	2809	
$(C_X/\sigma)_{10}$	2810	

$$\mu = \frac{1.688\, V_{KT}}{V_{TIP}}$$

$$C_T'/\sigma = \frac{\text{LIFT}}{\frac{\rho \pi D^2}{4} V_T^2 \sigma_{MR} N_R}$$

$$C_X/\sigma = \frac{\text{PROPULSIVE FORCE}}{\frac{\rho \pi D^2}{4} V_T^2 \sigma_{MR} N_R}$$

$$C_P/\sigma = \frac{2200 \times \text{ROTOR POWER (SHP)}}{\rho \pi D^2 V_T^3 \sigma_{MR} N_R}$$

NOTES: a. WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS
b. ALL TABLES MUST BE COMPLETELY FILLED.

FORM 83124 (8/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO. 3 OF 5	CASE NO.

ROTOR PERFORMANCE "MAP"
(ROTIND = 2,3)
CRUISE PERFORMANCE

INPUT VALUES OF ROTOR POWER COEFFICIENT $\left(\frac{C_P}{\sigma}\right)$ FOR COMBINATIONS OF $\mu, \frac{C_T'}{\sigma}, \& \frac{C_X}{\sigma}$

NOTE: ALL TABLES MUST BE COMPLETELY FILLED.

ROTOR PROPULSIVE FORCE COEFFICIENT

ADVANCE RATIO μ_1 =	$(C_X/\sigma)_1$ =		$(C_X/\sigma)_2$ =		$(C_X/\sigma)_3$ =		$(C_X/\sigma)_4$ =		$(C_X/\sigma)_5$ =		$(C_X/\sigma)_6$ =		$(C_X/\sigma)_7$ =		$(C_X/\sigma)_8$ =		$(C_X/\sigma)_9$ =		$(C_X/\sigma)_{10}$ =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	2811		2821		2831		2841		2851		2861		2871		2881		2891		2901	
$(C_T'/\sigma)_2$ =	2812		2822		2832		2842		2852		2862		2872		2882		2892		2902	
$(C_T'/\sigma)_3$ =	2813		2823		2833		2843		2853		2863		2873		2883		2893		2903	
$(C_T'/\sigma)_4$ =	2814		2824		2834		2844		2854		2864		2874		2884		2894		2904	
$(C_T'/\sigma)_5$ =	2815		2825		2835		2845		2855		2865		2875		2885		2895		2905	
$(C_T'/\sigma)_6$ =	2816		2826		2836		2846		2856		2866		2876		2886		2896		2906	
$(C_T'/\sigma)_7$ =	2817		2827		2837		2847		2857		2867		2877		2887		2897		2907	
$(C_T'/\sigma)_8$ =	2818		2828		2838		2848		2858		2868		2878		2888		2898		2908	
$(C_T'/\sigma)_9$ =	2819		2829		2839		2849		2859		2869		2879		2889		2899		2909	
$(C_T'/\sigma)_{10}$ =	2820		2830		2840		2850		2860		2870		2880		2890		2900		2910	

ADVANCE RATIO μ_2 =	$(C_X/\sigma)_1$ =		$(C_X/\sigma)_2$ =		$(C_X/\sigma)_3$ =		$(C_X/\sigma)_4$ =		$(C_X/\sigma)_5$ =		$(C_X/\sigma)_6$ =		$(C_X/\sigma)_7$ =		$(C_X/\sigma)_8$ =		$(C_X/\sigma)_9$ =		$(C_X/\sigma)_{10}$ =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	2911		2921		2931		2941		2951		2961		2971		2981		2991		3001	
$(C_T'/\sigma)_2$ =	2912		2922		2932		2942		2952		2962		2972		2982		2992		3002	
$(C_T'/\sigma)_3$ =	2913		2923		2933		2943		2953		2963		2973		2983		2993		3003	
$(C_T'/\sigma)_4$ =	2914		2924		2934		2944		2954		2964		2974		2984		2994		3004	
$(C_T'/\sigma)_5$ =	2915		2925		2935		2945		2955		2965		2975		2985		2995		3005	
$(C_T'/\sigma)_6$ =	2916		2926		2936		2946		2956		2966		2976		2986		2996		3006	
$(C_T'/\sigma)_7$ =	2917		2927		2937		2947		2957		2967		2977		2987		2997		3007	
$(C_T'/\sigma)_8$ =	2918		2928		2938		2948		2958		2968		2978		2988		2998		3008	
$(C_T'/\sigma)_9$ =	2919		2929		2939		2949		2959		2969		2979		2989		2999		3009	
$(C_T'/\sigma)_{10}$ =	2920		2930		2940		2950		2960		2970		2980		2990		3000		3010	

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO. 4 OF 5	CASE NO.

ROTOR PERFORMANCE "MAP"
(ROTIND = 2,3)

CRUISE PERFORMANCE INPUT VALUES OF ROTOR POWER COEFFICIENT $\left(\frac{C_P}{\sigma}\right)$ FOR COMBINATIONS OF $\mu, \frac{C_T'}{\sigma}$ & $\frac{C_X}{\sigma}$

NOTE: ALL TABLES MUST BE COMPLETELY FILLED.

ROTOR PROPULSIVE FORCE COEFFICIENT

ADVANCE RATIO μ_3 =	$(C_X/\sigma)_1$ =		$(C_X/\sigma)_2$ =		$(C_X/\sigma)_3$ =		$(C_X/\sigma)_4$ =		$(C_X/\sigma)_5$ =		$(C_X/\sigma)_6$ =		$(C_X/\sigma)_7$ =		$(C_X/\sigma)_8$ =		$(C_X/\sigma)_9$ =		$(C_X/\sigma)_{10}$ =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3011		3021		3031		3041		3051		3061		3071		3081		3091		3101	
$(C_T'/\sigma)_2$ =	3012		3022		3032		3042		3052		3062		3072		3082		3092		3102	
$(C_T'/\sigma)_3$ =	3013		3023		3033		3043		3052		3063		3073		3083		3093		3103	
$(C_T'/\sigma)_4$ =	3014		3024		3034		3044		3054		3064		3074		3084		3094		3104	
$(C_T'/\sigma)_5$ =	3015		3025		3035		3045		3055		3065		3075		3085		3095		3105	
$(C_T'/\sigma)_6$ =	3016		3026		3036		3046		3056		3066		3076		3086		3096		3106	
$(C_T'/\sigma)_7$ =	3017		3027		3037		3047		3057		3067		3077		3087		3097		3107	
$(C_T'/\sigma)_8$ =	3018		3028		3038		3048		3058		3068		3078		3088		3098		3108	
$(C_T'/\sigma)_9$ =	3019		3029		3039		3049		3059		3069		3079		3089		3099		3109	
$(C_T'/\sigma)_{10}$ =	3020		3030		3040		3050		3060		3070		3080		3090		3100		3110	
ADVANCE RATIO μ_4 =	$(C_X/\sigma)_1$ =		$(C_X/\sigma)_2$ =		$(C_X/\sigma)_3$ =		$(C_X/\sigma)_4$ =		$(C_X/\sigma)_5$ =		$(C_X/\sigma)_6$ =		$(C_X/\sigma)_7$ =		$(C_X/\sigma)_8$ =		$(C_X/\sigma)_9$ =		$(C_X/\sigma)_{10}$ =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3111		3121		3131		3141		3151		3161		3171		3181		3191		3201	
$(C_T'/\sigma)_2$ =	3112		3122		3132		3142		3152		3162		3172		3182		3192		3202	
$(C_T'/\sigma)_3$ =	3113		3123		3133		3143		3153		3163		3173		3183		3193		3203	
$(C_T'/\sigma)_4$ =	3114		3124		3134		3144		3154		3164		3174		3184		3194		3204	
$(C_T'/\sigma)_5$ =	3115		3125		3135		3145		3155		3165		3175		3185		3195		3205	
$(C_T'/\sigma)_6$ =	3116		3126		3136		3146		3156		3166		3176		3186		3196		3206	
$(C_T'/\sigma)_7$ =	3117		3127		3137		3147		3157		3167		3177		3187		3197		3207	
$(C_T'/\sigma)_8$ =	3118		3128		3138		3148		3158		3168		3178		3188		3198		3208	
$(C_T'/\sigma)_9$ =	3119		3129		3139		3149		3159		3169		3179		3189		3199		3208	
$(C_T'/\sigma)_{10}$ =	3120		3130		3140		3150		3160		3170		3180		3190		3200		3210	

BOEING VERTOL COMPANY

A DIVISION OF THE BOEING COMPANY

ROTOR PERFORMANCE "MAP"

(ROTIND = 2,3)

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO. 5 OF 5	CASE NO.

CRUISE PERFORMANCE **INPUT VALUES OF ROTOR POWER COEFFICIENT $\left(\frac{C_P}{\sigma}\right)$ FOR COMBINATIONS OF $\mu, \frac{C_T'}{\sigma}$ & $\frac{C_X}{\sigma}$**

NOTE: ALL TABLES MUST BE COMPLETELY FILLED. ROTOR PROPULSIVE FORCE COEFFICIENT

ADVANCE RATIO μ_5 =	$(C_X/\sigma)_1$ =		$(C_X/\sigma)_2$ =		$(C_X/\sigma)_3$ =		$(C_X/\sigma)_4$ =		$(C_X/\sigma)_5$ =		$(C_X/\sigma)_6$ =		$(C_X/\sigma)_7$ =		$(C_X/\sigma)_8$ =		$(C_X/\sigma)_9$ =		$(C_X/\sigma)_{10}$ =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3211		3221		3231		3241		3251		3261		3271		3281		3291		3301	
$(C_T'/\sigma)_2$ =	3212		3222		3232		3242		3252		3262		3272		3282		3292		3302	
$(C_T'/\sigma)_3$ =	3213		3223		3233		3243		3253		3263		3273		3283		3293		3303	
$(C_T'/\sigma)_4$ =	3214		3224		3234		3244		3254		3264		3274		3284		3294		3304	
$(C_T'/\sigma)_5$ =	3215		3225		3235		3245		3255		3265		3275		3285		3295		3305	
$(C_T'/\sigma)_6$ =	3216		3226		3236		3246		3256		3266		3276		3286		3296		3306	
$(C_T'/\sigma)_7$ =	3217		3227		3237		3247		3257		3267		3277		3287		3297		3307	
$(C_T'/\sigma)_8$ =	3218		3228		3238		3248		3258		3268		3278		3288		3298		3308	
$(C_T'/\sigma)_9$ =	3219		3229		3239		3249		3259		3269		3279		3289		3299		3309	
$(C_T'/\sigma)_{10}$ =	3220		3230		3240		3250		3260		3270		3280		3290		3300		3310	

ADVANCE RATIO μ_6 =	$(C_X/\sigma)_1$ =		$(C_X/\sigma)_2$ =		$(C_X/\sigma)_3$ =		$(C_X/\sigma)_4$ =		$(C_X/\sigma)_5$ =		$(C_X/\sigma)_6$ =		$(C_X/\sigma)_7$ =		$(C_X/\sigma)_8$ =		$(C_X/\sigma)_9$ =		$(C_X/\sigma)_{10}$ =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3311		3321		3331		3341		3351		3361		3371		3381		3391		3401	
$(C_T'/\sigma)_2$ =	3312		3322		3332		3342		3352		3362		3372		3382		3392		3402	
$(C_T'/\sigma)_3$ =	3313		3323		3333		3343		3353		3363		3373		3383		3393		3403	
$(C_T'/\sigma)_4$ =	3314		3324		3334		3344		3354		3364		3374		3384		3394		3404	
$(C_T'/\sigma)_5$ =	3315		3325		3335		3345		3355		3365		3375		3385		3395		3405	
$(C_T'/\sigma)_6$ =	3316		3326		3336		3346		3356		3366		3376		3386		3396		3406	
$(C_T'/\sigma)_7$ =	3317		3327		3337		3347		3357		3367		3377		3387		3397		3407	
$(C_T'/\sigma)_8$ =	3318		3328		3338		3348		3358		3368		3378		3388		3398		3408	
$(C_T'/\sigma)_9$ =	3319		3329		3339		3349		3359		3369		3379		3389		3399		3409	
$(C_T'/\sigma)_{10}$ =	3320		3330		3340		3350		3360		3370		3380		3390		3400		3410	

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
1 OF 5	

NOTE: WHEN OPTIND = 2 OR 3, CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

ROTOR PERFORMANCE MAP
(ROTIND = 4,5,6)

	LOC	VALUE
ROTOR MAP NO.	3420	

	LOC	VALUE
b_{REF}	3421	
σ_{REF}	3422	
$\theta_{T_{REF}}$	3423	

HOVER PERFORMANCE

	LOC	VALUE
NO. OF C_T/σ'S	3424	

	LOC	VALUE
NO. OF M_{TIP}'S	3435	

VALUES OF C_T/σ

	LOC	VALUE
$(C_T/\sigma)_1$	3425	
$(C_T/\sigma)_2$	3426	
$(C_T/\sigma)_3$	3427	
$(C_T/\sigma)_4$	3428	
$(C_T/\sigma)_5$	3429	
$(C_T/\sigma)_6$	3430	
$(C_T/\sigma)_7$	3431	
$(C_T/\sigma)_8$	3432	
$(C_T/\sigma)_9$	3433	
$(C_T/\sigma)_{10}$	3434	

VALUES OF M_{TIP}

	LOC	VALUE
M_{T_1}	3436	
M_{T_2}	3437	
M_{T_3}	3438	
M_{T_4}	3439	
M_{T_5}	3440	
M_{T_6}	3441	

$C_T/\sigma = 4T/\rho \pi D^2 V_T{}^2 N_R \sigma$

INPUT VALUES OF F.M. FOR COMBINATIONS OF C_T/σ AND M_{TIP}

	M_{TIP_1} =		M_{TIP_2} =		M_{TIP_3} =		M_{TIP_4} =		M_{TIP_5} =		M_{TIP_6} =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T/\sigma)_1$ =	3442		3452		3462		3472		3482		3492	
$(C_T/\sigma)_2$ =	3443		3453		3463		3473		3483		3493	
$(C_T/\sigma)_3$ =	3444		3454		3464		3474		3484		3494	
$(C_T/\sigma)_4$ =	3445		3455		3465		3475		3485		3495	
$(C_T/\sigma)_5$ =	3446		3456		3466		3476		3486		3496	
$(C_T/\sigma)_6$ =	3447		3457		3467		3477		3487		3497	
$(C_T/\sigma)_7$ =	3448		3458		3468		3478		3488		3498	
$(C_T/\sigma)_8$ =	3449		3459		3469		3479		3489		3499	
$(C_T/\sigma)_9$ =	3450		3460		3470		3480		3490		3500	
$(C_T/\sigma)_{10}$ =	3451		3461		3471		3481		3491		3501	

NOTES: a) C_T IS IN "ROTOR" NOTATION
b) ALL TABLES MUST BE COMPLETELY FILLED

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
2 OF 5	

**ROTOR PERFORMANCE "MAP"
(ROTIND = 4,5,6)**

CRUISE PERFORMANCE

	LOC	VALUE
NO. OF PROPULSIVE FORCE /LIFT RATIOS (X/L)	3502	

	LOC	VALUE
NO. OF ROTOR LIFT COEFFICIENTS (C_T'/σ)	3509	

	LOC	VALUE
NO. OF ADVANCE RATIOS (μ)	3520	

VALUES OF X/L

	LOC	VALUE
$(X/L)_1$	3503	
$(X/L)_2$	3504	
$(X/L)_3$	3505	
$(X/L)_4$	3506	
$(X/L)_5$	3507	
$(X/L)_6$	3508	

VALUES OF C_T'/σ

	LOC	VALUE
$(C_T'/\sigma)_1$	3510	
$(C_T'/\sigma)_2$	3511	
$(C_T'/\sigma)_3$	3512	
$(C_T'/\sigma)_4$	3513	
$(C_T'/\sigma)_5$	3514	
$(C_T'/\sigma)_6$	3515	
$(C_T'/\sigma)_7$	3516	
$(C_T'/\sigma)_8$	3517	
$(C_T'/\sigma)_9$	3518	
$(C_T'/\sigma)_{10}$	3519	

VALUES OF μ

	LOC	VALUE
μ_1	3521	
μ_2	3522	
μ_3	3523	
μ_4	3524	
μ_5	3525	
μ_6	3526	
μ_7	3527	
μ_8	3528	
μ_9	3529	
μ_{10}	3530	

$$\mu = \frac{1.688 V_{KT}}{V_{TIP}}$$

$$C_T'/\sigma = \frac{LIFT}{\frac{\rho \pi D^2}{4} V_T{}^2 \sigma_{MR} N_R}$$

$$X/L = \frac{\text{ROTOR PROPULSIVE FORCE}}{\text{ROTOR LIFT}}$$

NOTES: a) AT LEAST 3 VALUES OF X/L, C_T'/σ, AND μ MUST BE INPUT
b) WHEN OPTIND = 2 OR 3, CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS
c) ALL TABLES MUST BE COMPLETELY FILLED.

FORM 93451 (6/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
3 OF 5	

ROTOR PERFORMANCE "MAP" (ROTIND = 4,5,6)

CRUISE PERFORMANCE

INPUT VALUES OF ROTOR L/D_E FOR COMBINATIONS OF μ, $\frac{C_T'}{\sigma}$ & X/L

NOTE: ALL TABLES MUST BE COMPLETELY FILLED

ROTOR ADVANCE RATIO

PROPULSIVE FORCE /LIFT RATIO $(X/L)_1$	μ_1 =		μ_2 =		μ_3 =		μ_4 =		μ_5 =		μ_6 =		μ_7 =		μ_8 =		μ_9 =		μ_{10} =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3531		3541		3551		3561		3571		3581		3591		3601		3611		3621	
$(C_T'/\sigma)_2$ =	3532		3542		3552		3562		3572		3582		3592		3602		3612		3622	
$(C_T'/\sigma)_3$ =	3533		3543		3553		3563		3573		3583		3593		3603		3613		3623	
$(C_T'/\sigma)_4$ =	3534		3544		3554		3564		3574		3584		3594		3604		3614		3624	
$(C_T'/\sigma)_5$ =	3535		3545		3555		3565		3575		3585		3595		3605		3615		3625	
$(C_T'/\sigma)_6$ =	3536		3546		3556		3566		3576		3586		3596		3606		3616		3626	
$(C_T'/\sigma)_7$ =	3537		3547		3557		3567		3577		3587		3597		3607		3617		3627	
$(C_T'/\sigma)_8$ =	3538		3548		3558		3568		3578		3588		3598		3608		3618		3628	
$(C_T'/\sigma)_9$ =	3539		3549		3559		3569		3579		3589		3599		3609		3619		3629	
$(C_T'/\sigma)_{10}$ =	3540		3550		3560		3570		3580		3590		3600		3610		3620		3630	

PROPULSIVE FORCE /LIFT RATIO $(X/L)_2$	μ_1 =		μ_2 =		μ_3 =		μ_4 =		μ_5 =		μ_6 =		μ_7 =		μ_8 =		μ_9 =		μ_{10} =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3631		3641		3651		3661		3671		3681		3691		3701		3711		3721	
$(C_T'/\sigma)_2$ =	3632		3642		3652		3662		3672		3682		3692		3702		3712		3722	
$(C_T'/\sigma)_3$ =	3633		3643		3653		3663		3673		3683		3693		3703		3713		3723	
$(C_T'/\sigma)_4$ =	3634		3644		3654		3664		3674		3684		3694		3704		3714		3724	
$(C_T'/\sigma)_5$ =	3635		3645		3655		3665		3675		3685		3695		3705		3715		3725	
$(C_T'/\sigma)_6$ =	3636		3646		3656		3666		3676		3686		3696		3706		3716		3726	
$(C_T'/\sigma)_7$ =	3637		3647		3657		3667		3677		3687		3697		3707		3717		3727	
$(C_T'/\sigma)_8$ =	3638		3648		3658		3668		3678		3688		3698		3708		3718		3728	
$(C_T'/\sigma)_9$ =	3639		3649		3659		3669		3679		3689		3699		3709		3719		3729	
$(C_T'/\sigma)_{10}$ =	3640		3650		3660		3670		3680		3690		3700		3710		3720		3730	

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
4 OF 5	

ROTOR PERFORMANCE "MAP"
(ROTIND = 4,5,6)

CRUISE PERFORMANCE

INPUT VALUES OF ROTOR L/D_E FOR COMBINATIONS OF μ, $\frac{C_T'}{\sigma}$ & X/L

NOTE: ALL TABLES MUST BE COMPLETELY FILLED

ROTOR ADVANCE RATIO

PROPULSIVE FORCE /LIFT RATIO	μ_1 =		μ_2 =		μ_3 =		μ_4 =		μ_5 =		μ_6 =		μ_7 =		μ_8 =		μ_9 =		μ_{10} =	
$(X/L)_3$	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3731		3741		3751		3761		3771		3781		3791		3801		3811		3821	
$(C_T'/\sigma)_2$ =	3732		3742		3752		3762		3772		3782		3792		3802		3812		3822	
$(C_T'/\sigma)_3$ =	3733		3743		3753		3763		3773		3783		3793		3803		3813		3823	
$(C_T'/\sigma)_4$ =	3734		3744		3754		3764		3774		3784		3794		3804		3814		3824	
$(C_T'/\sigma)_5$ =	3735		3745		3755		3765		3775		3785		3795		3805		3815		3825	
$(C_T'/\sigma)_6$ =	3736		3746		3756		3766		3776		3786		3796		3806		3816		3826	
$(C_T'/\sigma)_7$ =	3737		3747		3757		3767		3777		3787		3797		3807		3817		3827	
$(C_T'/\sigma)_8$ =	3738		3748		3758		3768		3778		3788		3798		3808		3818		3828	
$(C_T'/\sigma)_9$ =	3739		3749		3759		3769		3779		3789		3799		3809		3819		3829	
$(C_T'/\sigma)_{10}$ =	3740		3750		3760		3770		3780		3790		3800		3810		3820		3830	

PROPULSIVE FORCE /LIFT RATIO	μ_1 =		μ_2 =		μ_3 =		μ_4 =		μ_5 =		μ_6 =		μ_7 =		μ_8 =		μ_9 =		μ_{10} =	
$(X/L)_4$	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3831		3841		3851		3861		3871		3881		3891		3901		3911		3921	
$(C_T'/\sigma)_2$ =	3832		3842		3852		3862		3872		3882		3892		3902		3912		3922	
$(C_T'/\sigma)_3$ =	3833		3843		3853		3863		3873		3883		3893		3903		3913		3923	
$(C_T'/\sigma)_4$ =	3834		3844		3854		3864		3874		3884		3894		3904		3914		3924	
$(C_T'/\sigma)_5$ =	3835		3845		3855		3865		3875		3885		3895		3905		3915		3925	
$(C_T'/\sigma)_6$ =	3836		3846		3856		3866		3876		3886		3896		3906		3916		3926	
$(C_T'/\sigma)_7$ =	3837		3847		3857		3867		3877		3887		3897		3907		3917		3927	
$(C_T'/\sigma)_8$ =	3838		3848		3858		3868		3878		3888		3898		3908		3918		3928	
$(C_T'/\sigma)_9$ =	3839		3849		3859		3869		3879		3889		3899		3909		3919		3929	
$(C_T'/\sigma)_{10}$ =	3840		3850		3860		3870		3880		3890		3900		3910		3920		3930	

FORM 53483 (8/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE
COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
5 OF 5	

ROTOR PERFORMANCE "MAP"
(ROTIND = 4,5,6)

INPUT VALUES OF ROTOR L/D_E FOR COMBINATIONS OF μ, $\frac{C_{T_1}'}{\sigma}$ & X/L

CRUISE PERFORMANCE

NOTE: ALL TABLES MUST BE COMPLETELY FILLED

ROTOR ADVANCE RATIO

PROPULSIVE FORCE /LIFT RATIO $(X/L)_5$	μ_1 =		μ_2 =		μ_3 =		μ_4 =		μ_5 =		μ_6 =		μ_7 =		μ_8 =		μ_9 =		μ_{10} =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	3931		3941		3951		3961		3971		3981		3991		4001		4011		4021	
$(C_T'/\sigma)_2$ =	3932		3942		3952		3962		3972		3982		3992		4002		4012		4022	
$(C_T'/\sigma)_3$ =	3933		3943		3953		3963		3973		3983		3993		4003		4013		4023	
$(C_T'/\sigma)_4$ =	3934		3944		3954		3964		3974		3984		3994		4004		4014		4024	
$(C_T'/\sigma)_5$ =	3935		3945		3955		3965		3975		3985		3995		4005		4015		4025	
$(C_T'/\sigma)_6$ =	3936		3946		3956		3966		3976		3986		3996		4006		4016		4026	
$(C_T'/\sigma)_7$ =	3937		3947		3957		3967		3977		3987		3997		4007		4017		4027	
$(C_T'/\sigma)_8$ =	3938		3948		3958		3968		3978		3988		3998		4008		4018		4028	
$(C_T'/\sigma)_9$ =	3939		3949		3959		3969		3979		3989		3999		4009		4019		4029	
$(C_T'/\sigma)_{10}$ =	3940		3950		3960		3970		3980		3990		4000		4010		4020		4030	
PROPULSIVE FORCE /LIFT RATIO $(X/L)_6$	μ_1 =		μ_2 =		μ_3 =		μ_4 =		μ_5 =		μ_6 =		μ_7 =		μ_8 =		μ_9 =		μ_{10} =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T'/\sigma)_1$ =	4031		4041		4051		4061		4071		4081		4091		4101		41[illegible]		4121	
$(C_T'/\sigma)_2$ =	4032		4042		4052		4062		4072		4082		4092		4102		4112		4122	
$(C_T'/\sigma)_3$ =	4033		4043		4053		4063		4073		4083		4093		4103		4113		4123	
$(C_T'/\sigma)_4$ =	4034		4044		4054		4064		4074		4084		4094		4104		4114		4124	
$(C_T'/\sigma)_5$ =	4035		4045		4055		4065		4075		4085		4095		4105		4115		4125	
$(C_T'/\sigma)_6$ =	4036		4046		4056		4066		4076		4086		4096		4106		4116		4126	
$(C_T'/\sigma)_7$ =	4037		4047		4057		4067		4077		4087		4097		4107		4117		4127	
$(C_T'/\sigma)_8$ =	4038		4048		4058		4068		4078		4088		4098		4108		4118		4128	
$(C_T'/\sigma)_9$ =	4039		4049		4059		4069		4079		4089		4099		4109		4119		4129	
$(C_T'/\sigma)_{10}$ =	4040		4050		4060		4070		4080		4090		4100		4110		4120		4130	

FORM 58484 (8/79)

INCREMENTAL ROTOR PERFORMANCE INPUT

(USE WHEN ROTIND = 4,5,6)

HOVER PERFORMANCE

INCREMENTAL ROTOR FIGURE OF MERIT INPUT

	Δ F.M.		0195	

CRUISE PERFORMANCE

	LOC	VALUE
NO. OF PAIRS IN μ-$\Delta L/D_E$ TABLE	1279	

INCREMENTAL ROTOR L/D_E

	LOC	VALUE		LOC	VALUE
VALUES OF μ	1280		VALUES OF $\Delta L/D_E$	1290	
	1281			1291	
	1282			1292	
	1283			1293	
	1284			1294	
	1285			1295	
	1286			1296	
	1287			1297	
	1288			1298	
	1289			1299	

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

PROPELLER PERFORMANCE DATA (Sheet 1 of 3)

THIS SHEET IS REQUIRED WHEN η_pIND = 1

NOTES: AT LEAST 3 VALUES OF J AND 3 VALUES OF C_T MUST BE USED
WHEN OPTIND = 2,3, CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

	LOC.	VALUE
PROP. TABLE NO.	1700	

	LOC.	VALUE
NO. OF ADVANCE RATIOS (J)	1701	

	LOC.	VALUE
NO. OF PROP THRUST COEFFICIENTS (C_T)	1722	

VALUES OF J

	LOC.	VALUE
J_1	1702	
J_2	1703	
J_3	1704	
J_4	1705	
J_5	1706	
J_6	1707	
J_7	1708	
J_8	1709	
J_9	1710	
J_{10}	1711	
J_{11}	1712	
J_{12}	1713	
J_{13}	1714	
J_{14}	1715	
J_{15}	1716	
J_{16}	1717	
J_{17}	1718	
J_{18}	1719	
J_{19}	1720	
J_{20}	1721	

VALUES OF C_T

	LOC.	VALUE
C_{T_1}	1723	
C_{T_2}	1724	
C_{T_3}	1725	
C_{T_4}	1726	
C_{T_5}	1727	
C_{T_6}	1728	
C_{T_7}	1729	
C_{T_8}	1730	
C_{T_9}	1731	
$C_{T_{10}}$	1732	
$C_{T_{11}}$	1733	
$C_{T_{12}}$	1734	
$C_{T_{13}}$	1735	
$C_{T_{14}}$	1736	
$C_{T_{15}}$	1737	
$C_{T_{16}}$	1738	
$C_{T_{17}}$	1739	
$C_{T_{18}}$	1740	
$C_{T_{19}}$	1741	
$C_{T_{20}}$	1742	

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

PROPELLER PERFORMANCE DATA (Sheet 2 of 3)

THIS SHEET IS REQUIRED WHEN η_P IND = 1

INPUT VALUES OF PROPELLER POWER COEFFICIENT FOR COMBINATIONS OF J & C_T

PROPELLER THRUST COEFFICIENT

ADVANCE RATIO	C_{T_1} =		C_{T_2} =		C_{T_3} =		C_{T_4} =		C_{T_5} =		C_{T_6} =		C_{T_7} =		C_{T_8} =		C_{T_9} =		$C_{T_{10}}$ =	
	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE
J_1 =	1743		1763		1783		1803		1823		1843		1863		1883		1903		1923	
J_2 =	1744		1764		1784		1804		1824		1844		1864		1884		1904		1924	
J_3 =	1745		1765		1785		1805		1825		1845		1865		1885		1905		1925	
J_4 =	1746		1766		1786		1806		1826		1846		1866		1886		1906		1926	
J_5 =	1747		1767		1787		1807		1827		1847		1867		1887		1907		1927	
J_6 =	1748		1768		1788		1808		1828		1848		1868		1888		1908		1928	
J_7 =	1749		1769		1789		1809		1829		1849		1869		1889		1909		1929	
J_8 =	1750		1770		1790		1810		1830		1850		1870		1890		1910		1930	
J_9 =	1751		1771		1791		1811		1831		1851		1871		1891		1911		1931	
J_{10} =	1752		1772		1792		1812		1832		1852		1872		1892		1912		1932	
J_{11} =	1753		1773		1793		1813		1833		1853		1873		1893		1913		1933	
J_{12} =	1754		1774		1794		1814		1834		1854		1874		1894		1914		1934	
J_{13} =	1755		1775		1795		1815		1835		1855		1875		1895		1915		1935	
J_{14} =	1756		1776		1796		1816		1836		1856		1876		1896		1916		1936	
J_{15} =	1757		1777		1797		1817		1837		1857		1877		1897		1917		1937	
J_{16} =	1758		1778		1798		1818		1838		1858		1878		1898		1918		1938	
J_{17} =	1759		1779		1799		1819		1839		1859		1879		1899		1919		1939	
J_{18} =	1760		1780		1800		1820		1840		1860		1880		1900		1920		1940	
J_{19} =	1761		1781		1801		1821		1841		1861		1881		1901		1921		1941	
J_{20} =	1762		1782		1802		1822		1842		1862		1882		1902		1922		1942	

NOTES: 1. IF MORE THAN 10 VALUES OF C_T ARE REQUIRED, USE SHEET 3 FOR CONTINUATION OF TABLE.
2. WHEN OPTIND = 2,3, CONSIDER ONLY THOSE ITEMS IN SHADED BLOCKS

FORM 59100 (8/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO.	CASE NO.
OF	

PROPELLER PERFORMANCE DATA (Sheet 3 of 3)

THIS SHEET IS REQUIRED WHEN η_pIND = 1

INPUT VALUES OF PROPELLER POWER COEFFICIENT FOR COMBINATIONS OF J & C_T

PROPELLER THRUST COEFFICIENT

ADVANCE RATIO	$C_{T_{11}}$=		$C_{T_{12}}$=		$C_{T_{13}}$=		$C_{T_{14}}$=		$C_{T_{15}}$=		$C_{T_{16}}$=		$C_{T_{17}}$=		$C_{T_{18}}$=		$C_{T_{19}}$=		$C_{T_{20}}$=	
	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE
J_1 =	1943		1963		1983		2003		2023		2043		2063		2083		2103		2123	
J_2 =	1944		1964		1984		2004		2024		2044		2064		2084		2104		2124	
J_3 =	1945		1965		1985		2005		2025		2045		2065		2085		2105		2125	
J_4 =	1946		1966		1986		2006		2026		2046		2066		2086		2106		2126	
J_5 =	1947		1967		1987		2007		2027		2047		2067		2087		2107		2127	
J_6 =	1948		1968		1988		2008		2028		2048		2068		2088		2108		2128	
J_7 =	1949		1969		1989		2009		2029		2049		2069		2089		2109		2129	
J_8 =	1950		1970		1990		2010		2030		2050		2070		2090		2110		2130	
J_9 =	1951		1971		1991		2011		2031		2051		2071		2091		2111		2131	
J_{10}=	1952		1972		1992		2012		2032		2052		2072		2092		2112		2132	
J_{11}=	1953		1973		1993		2013		2033		2053		2073		2093		2113		2133	
J_{12}=	1954		1974		1994		2014		2034		2054		2074		2094		2114		2134	
J_{13}=	1955		1975		1995		2015		2035		2055		2075		2095		2115		2135	
J_{14}=	1956		1976		1996		2016		2036		2056		2076		2096		2116		2136	
J_{15}=	1957		1977		1997		2017		2037		2057		2077		2097		2117		2137	
J_{16}=	1958		1978		1998		2018		2038		2058		2078		2098		2118		2138	
J_{17}=	1959		1979		1999		2019		2039		2059		2079		2099		2119		2139	
J_{18}=	1960		1980		2000		2020		2040		2060		2080		2100		2120		2140	
J_{19}=	1961		1981		2001		2021		2041		2061		2081		2101		2121		2141	
J_{20}=	1962		1982		2002		2022		2042		2062		2082		2102		2122		2142	

NOTE: WHEN OPTIND = 2,3, CONSIDER ONLY THOSE ITEMS IN SHADED BLOCKS

FORM 53108 (8/79)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

HESCOMP HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM B-91

SHEET NO. OF	CASE NO.

SUPPLEMENTARY INPUT

VARIABLE	LOC	VALUE	VARIABLE	LOC	VALUE	VARIABLE	LOC	VALUE

FORM 53146 (8/79)

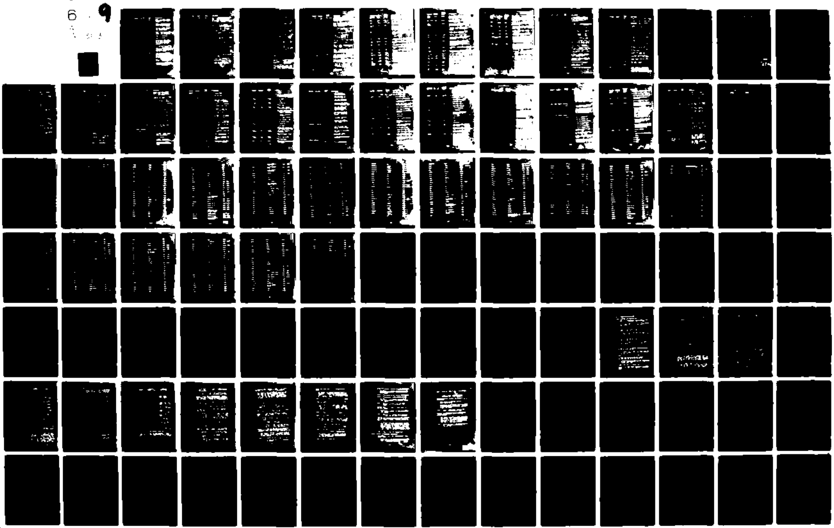
[illegible]

[illegible]

Variable	Location	[illegible]	Description
AF	[illegible]	AF	[illegible] propeller.
AR	0104	DAM 2	Wing aspect ratio
AR_{AP}	0159	ARAP	Aft rotor pylon aspect ratio (tandem rotor helicopter)
AR_{FP}	0154	ARFP	Forward rotor pylon aspect ratio (tandem rotor helicopter)
AR_{HT}	0112	ARHT	Horizontal tail aspect ratio
AR_{VT}	0135	DAM 11	Vertical tail aspect ratio
BHP			Brake horsepower of [illegible] engine including [illegible] and power [illegible]. BHP is synonymous [illegible] horsepower (SHP).
BHP1			Brake horsepower of [illegible] engine including [illegible] and power [illegible]. BHP1 is synonymous [illegible]
[illegible]	0176		Blade [illegible] for [illegible] or propeller.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

AD-A113 037 BOEING VERTOL CO PHILADELPHIA PA F/G 9/2
HESCOMP. THE HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM--ETC(U)
OCT 79 S J DAVIS, H ROSENSTEIN, K A STANZIONE N62269-79-C-0217
UNCLASSIFIED D210-10699-2-REV-2. NADC-78265-60 NL

6 - 9



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6 OF 9

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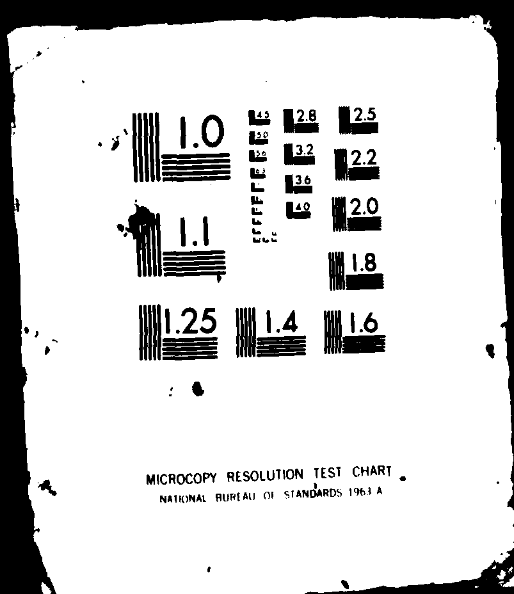

[illegible]	$K_{[illegible]}$	[illegible]
[illegible]	$K_{[illegible]}$	[illegible]
[illegible]	K_{SC}	[illegible]
[illegible]	K_{SCA}	[illegible]
[illegible]	K_{T} [illegible]	[illegible]
[illegible]	K_{TN}	[illegible]
[illegible]	K_{TR}	[illegible]
[illegible]	K_{TRUS}	[illegible]
[illegible]	K_{VTAR}	[illegible]
[illegible]	K_{WP}	[illegible]
[illegible]	K_{WS}	[illegible]
[illegible]	K_{WV}	[illegible]
[illegible]	K_{ZZZ}	0213
[illegible]	λ	[illegible]
[illegible]	λ AP	[illegible]
[illegible]	λ FP	[illegible]
[illegible]	λ [illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	σ REF.	[illegible]
[illegible]	σ REF.	[illegible]
[illegible] (10)	Z_{FW}	[illegible]
[illegible]	[illegible] PROFILE [illegible]	[illegible]
[illegible] ([illegible])	$C_{[illegible]}$ ([illegible])	[illegible]
[illegible] ([illegible])	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

6.0 PROGRAM OUTPUT

A reproduction of the program output for three sample cases is included in Section 7.0. The following discussion describes the program printout in general and lists the diagnostic error printouts which are possible.

6.1 DESCRIPTION OF PRINTOUT

The printout for HESCOMP consists of four types of information:

a. General
b. Input Data
c. Sizing Data (program output)
d. Mission Performance Data (for the "sized" helicopter)

The general information (item a) is printed out at the beginning of each new case. Each of the other groupings (input, sizing data, and performance data) starts on a new page. For cases with OPTIND = 2 or 3 (performance only), the sizing data is not printed out. The printout is described in detail below.

6.1.1 General Printout

6.1.1.1 Fixed Heading:

HESCOMP

HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM

Depending on the configuration options (CNFIND, AUXIND, AIPIND, ENGIND) chosen, one of the following statements will be printed out.

SINGLE ROTOR PURE HELICOPTER

SINGLE ROTOR WINGED HELICOPTER

SINGLE ROTOR COMPOUND HELICOPTER

SINGLE ROTOR COMPOUND HELICOPTER AUXILIARY INDEPENDENT T/SHAFT CRUISE PROPULSION

SINGLE ROTOR COMPOUND HELICOPTER AUXILIARY INDEPENDENT T/FAN OR T/JET CRUISE PROPULSION

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER AUXILIARY INDEPENDENT T/SHAFT CRUISE PROPULSION

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER AUXILIARY INDEPENDENT T/FAN OR T/JET CRUISE PROPULSION

The printout for the tandem rotor configurations will be identical except for the substitution of TANDEM ROTOR for SINGLE ROTOR

6.1.1.2 Arbitrary Heading

An arbitary heading may be input by the user on a title card (see Section 5.2, input sheet for general information).

6.1.2 Input Data

All program input data is printed out as it appears on the data cards. Seven columns are printed. These correspond to the first location on the card, the number of variables on the card (from 1 to 5), and the values of these variables. With this information and a copy of the input sheets it is possible to determine the input value for any variable.

6.1.3 Sizing Data

This group is printed out only if OPTIND = 1. The data is represented by a symbol, followed by a written description, followed by the value with the units. For example:

WG/A DISC LOADING 10.0 LB/SQFT

The data is printed out in groups, each group having a heading. The specific variables which are printed out will depend upon certain options chosen. Notations are made in the following list to show where this occurs.

6.1.3.1 Dimensional Data

Single Rotor Helicopter

Fuselage:

ℓ_F, ℓ_C, ℓ_B, ℓ_{TB}, X_M, w_F, S_F

Wing:

If AUXIND = 2 or 4 print AR, S_W, b_W, C_W, $\lambda_{c/4}$, λ, $(t/c)_T$, W_G/S_W, G_{RW}, C_F/C

If AUXIND = 1 or 3 print NO WING USED

Horizontal Tail:

If HTIND = 1 or 2 print AR_{HT}, S_{HT}, b_{HT}, C_{HT}, λ_{HT}, L_{TH}

If HTIND = 0 print NO HORIZONTAL TAIL USED

Vertical Tail:

AR_{VT}, S_{VT}, b_{VT}, C_{VT}, λ_{VT}, Z_{TR}, ζ_{VT}, $(T/C)_{VT}$

Main Rotor Pylon:

AR, S_{FP}, FA_{FP}, H_{P_1}, C_{FP}, λ_{FP}, $(T/C)_R$, $(T/C)_T$

Primary Engine Nacelle:

ℓ_N, D_N, S_N

Auxiliary Independent Engine Nacelle:

If AIPIND = 2 print L_{NI}, D_{NI}, S_{NI}

Auxiliary Independent Engine Nacelle Strut:

If AIPIND = 2 print S_{STR}, b_{NS}, C_{NS}

Auxiliary Independent Propulsion:

If AIPIND = 2 and ENGIND = 1, print AUXILIARY INDEPENDENT PROPULSION - TURBOFAN (OR TURBOJET) ENGINE

If AIPIND = 1 print NO AUXILIARY INDEPENDENT ENGINE USED

Propeller (Auxiliary Propulsion):

If AUXIND = 3 or 4 and ENGIND = 0 print D_{AR}, AF, σ_{AR}, N_{RA}, NO. BLADES, V_{TIP}

If AUXIND = 1 or 2 print NO PROPELLER USED

Main Rotor:

D_{MR}, σ_{MR}, W_G/A, C_T/σ, N_R, NO BLADES, θ_{MR}, X_C, V_{TIP}

Tail Rotor:

D_{TR}, σ_{TR}, $(T/A)_{NET}$, C_T/σ, NO BLADES, θ_{TR}, X_{CTR}, G, V_{TIP}

Tandem Rotor Helicopter

Fuselage:

ℓ_F, ℓ_C, ΔX_1, ΔX_2, w_F, G/S, (O/L/D), S_F

Wing:

Same printout as single rotor helicopter

Forward Rotor Pylon:

AR, S_{FP}, FA_{FP}, H_{P_1}, C_{FP}, λ_{FP}, $(T/C)_R$, $(T/C)_T$

Aft Rotor Pylon:

AR, S_{AP}, H_{P_2}, C_{AP}, λ_{AP}, $(T/C)_R$, $(T/C)_T$

Primary Engine Nacelle:

ℓ_N, D_N, S_N

Auxiliary Independent Engine Nacelle:

Same printout as single rotor helicopter

Auxiliary Independent Engine Nacelle Strut:

Same printout as single rotor helicopter

Auxiliary Independent Propulsion:

Same printout as single rotor helicopter

Propeller (Auxiliary Propulsion):

Same printout as single rotor helicopter

Main Rotor:

Same printout as single rotor helicopter

6.1.3.2 Weights Data

Single and Tandem Rotor Helicopters

First print M_{LF}, G_{LF}, U_{LF}, then print,

Propulsion Group:

W_{PRG}, $K_{12}W_{PRB}$, $K_{13}W_{PH}$, W_{BF}, $K_{15}W_{AR}$, W_{DS}, $K_{16}W_{PDS}$, $K_{20}W_{TRDS}$, $K_{17}W_{ADS}$, $K_{18}W_{EP}$, $K_{19}W_{EA}$, W_{PEI}, W_{AEI}, W_{FS}, ΔW_P, W_P .

Structures Group:

K_8W_W, W_{TG}, K_9W_{HT}, $K_{14}W_{TR}$, K_6W_B, K_7W_{LG}, W_{NG}, W_{MG}, W_{TES}, W_{PES}, W_{AES}, ΔW_{ST}, W_{ST}

Flight Controls Group:

W_{PFC}, W_{CC}, K_1W_{RC}, K_2 SC, K_3W_{FW}, W_{TM}, W_{SAS}, W_{AFC}, K_4W_{RCA}, K_5W_{SCA}, W_{MC}, ΔW_{FC}, W_{FC}

Weight of Fixed Equipment:

W_{FE}

Weight Empty

WE

Fixed Useful Load

W_{FUL}

Operating Weight Empty

OWE

Payload

W_{PL}

Fuel

$(W_F)_A$

Gross Weight

WG

6.1.3.3 Rotor Data

Single Rotor Helicopter

ROTOR CYCLE NO. ________
(printed if ROTIND = 1)

ROTOR MAP NO. ________
(printed if ROTIND = 2)

FIXED MAIN ROTOR SOLIDITY INPUT
(printed if RDMIND = 1 or 2)

If RDMIND = 3 or 4, and depending on which solidity sizing requirement is most critical, one of the following statements will be printed out:

MAIN ROTOR SOLIDITY SIZED BY MANEUVER CONDITIONS
H = ______ FT., TEMP. = ______ DEG., V = _______ KT.
ROTOR MANEUVER G'S = ________, C_T/σ = _________

MAIN ROTOR SOLIDITY SIZED BY HOVER CONDITIONS
H = ______ FT., TEMP. = ______ DEG., T/W = ________
C_T/σ = ________

MAIN ROTOR SOLIDITY SIZED BY CRUISE CONDITIONS
H = ______ FT., TEMP. = ______ DEG., V = _______ KT.
ROTOR LIFT/GW FRACTION = __________ C_T/σ = _______

Which is followed by:

FIXED TAIL ROTOR SOLIDITY
(printed if TRSIND = 1)

TAIL ROTOR SIZED AT ______ TIMES THE SOLIDITY REQUIRED TO SATISFY HOVER ANTI-TORQUE REQUIREMENTS AT
H = ______ FT., TEMP. = ______ DEG.F., $C_{T_G}/C_{T_{NET}}$ = ________
(printed if TRSIND = 2 and $\dot{\psi} = 0$, $\ddot{\psi} = 0$)

TAIL ROTOR SIZED AT _______ TIMES THE SOLIDITY REQUIRED TO SATISFY HOVERING TURN REQUIREMENTS AT

H	=	_______	FT.
TEMP	=	_______	F.
$C_{T_G}/C_{T_{NET}}$	=	_______	DEG.
YAW RATE	=	_______	RAD/SEC
YAW ACCELERATION	=	_______	RAD/SEC^2
TAIL ROTOR POLAR MOM. OF INERTIA	=	_______	SLUG/FT^2
HELICOPTER YAW MOM. OF INERTIA	=	_______	SLUG/FT^2

(printed if TRSIND = 2 and $\dot{\psi}$ or $\ddot{\psi} \neq 0$.)

Tandem Rotor Helicopter

Main rotor data printout same as for single rotor helicopter.

6.1.3.4 Propulsion Data

Single Rotor Helicopter

PRIMARY PROPULSION CYCLE NO. _______
TURBOSHAFT ENGINE

_______ ENGINES

BHP*P MAX. STANDARD S.L. STATIC H.P. = _______ H.P.

ENGINE SIZE WAS FIXED BY INPUT
(printed if FIXIND = 0)

IF ESCIND = 1 print;

ENGINE SIZED FOR TAKEOFF AT T/W = _______,
H = _______ FT., TEMP. = _______ DEG.F.
AND _______ ENGINES INOPERATIVE

If ESCIND = 2 either of the following statements are printed depending on which engine sizing requirement (hover or cruise) is critical.

ENGINE SIZED FOR TAKEOFF AT T/W = _______,
H = _______ FT., TEMP. = _______ DEG.F.
AND _______ ENGINES INOPERATIVE

ENGINE SIZED FOR CRUISE AT V_C = _______ KNOTS
H = _______ FT., TEMP. = _______ DEG.F.
AND _______ ENGINES INOPERATIVE

Which is followed by:

NO AUX. INDEPENDENT ENGINE CYCLE SELECTED
(printed if AUXIND = 3 or 4 and AIPIND = 1)

AUX. INDEPENDENT PROPULSION CYCLE NO. _______
(printed if AUXIND = 3 or 4 and AIPIND = 2)

IF ENGIND = 0.0, TURBOSHAFT ENGINE is printed
IF ENGIND = 1.0, either TURBOFAN or TURBOJET ENGINE is printed

_______ ENGINES

BHP*P MAX. STANDARD S.L. STATIC H.P. _______ H.P.
(printed if ENGIND = 0.0)

T*P MAX. STANDARD S.L. STATIC THRUST ______ LBS.
(printed if ENGIND = 1.0)

ENGINE SIZE WAS FIXED BY INPUT
(printed if FIXINDI = 0.0)

ENGINE SIZED FOR CRUISE AT V_C _______ KNOTS
H = _______ FT., TEMP. = _______ DEG.F.
(printed if FIXINDI = 1.0)

MAIN DRIVE SYSTEM RATING __________H.P.
MAIN ROTOR DRIVE SYSTEM RATING __________H.P.

Depending on the transmission sizing option chosen (XMSNIND), and the results of the sizing, one of the following four statements will be printed:

XMSN SIZED AT _______ PERCENT OF TOTAL PRIMARY
ENGINE INSTALLED POWER
MAX. STANDARD S.L. STATIC H.P.
(printed if XMSNIND = 1.0)

XMSN SIZED AT _______ PERCENT OF MAIN ROTOR HOVER
POWER REQUIRED AT
H = _______ FT., TEMP. = _______ DEG.F.
(printed if XMSNIND = 2 or if XMSNIND = 3 and the alternate payload hover is not critical)

XMSN SIZED AT _______ PERCENT OF MAIN ROTOR HOVER
POWER REQUIRED AT ALTERNATE
PAYLOAD = ______ LBS., ALTERNATE GROSS WEIGHT = ______LBS.
H = _______ FT., TEMP. = _______ DEG.F.
(printed if XMSNIND = 3 and the alternate payload hover is critical)

XMSN SIZED AT _______ PERCENT OF MAIN ROTOR CRUISE
POWER REQUIRED AT V_C = _______ KT.,
H = _______ FT., TEMP. = _______ DEG.F.
(printed if XMSNIND = 2 or if XMSNIND = 3 and the alternate payload hover is not critical)

Which is followed by:

TAIL ROTOR DRIVE SYSTEM RATING _______H.P.
(printed if CNFIND = 1)

Depending on the transmission sizing option chosen (XMSNIND) and the results of the sizing, one of the following four statements will be printed:

XMSN SIZED AT ______ PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
MAX. STANDARD S.L. STATIC H.P.
(printed if XMSNIND = 1.0)

XMSN SIZED AT ______ PERCENT OF TAIL ROTOR HOVER POWER REQUIRED
AT H = ______ FT., TEMP. = ______ DEG.F.
(printed if XMSNIND = 2 or if XMSNIND = 3 and the alternate payload hover is not critical)

XMSN SIZED AT ______ PERCENT OF TAIL ROTOR HOVER POWER REQUIRED AT ALTERNATE
PAYLOAD = ______ LBS., ALTERNATE GROSS WEIGHT = ______ LBS.
H = ______ FT., TEMP. = ______ DEG.F.
(printed if XMSNIND = 3 and the alternate payload hover is critical)

XMSN SIZED AT ______ PERCENT OF TAIL ROTOR CRUISE POWER REQUIRED AT V_C = ______ KT.
H = ______ FT., TEMP. = ______ DEG.F.
(printed if XMSNIND = 2 or if XMSNIND = 3 and the alternate payload hover is not critical)

Which is followed by:

AUXILIARY PROPULSION DRIVE SYSTEM RATING ______ H.P.
(printed if AUXIND = 3 or 4 and AIPIND = 1)

Depending on the transmission sizing option chosen (XMSNIND) and the results of the sizing one of the following three statements will be printed:

XMSN SIZED AT ______ PERCENT OF TOTAL CONFIGURATION POWER REQUIRED TO HOVER
AT H = ______ FT., TEMP. = ______ DEG.F.
(printed if ESCIND = 1.0 and XMSNIND = 2 or 3)

XMSN SIZED AT ______ PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
MAX. STANDARD S.L. STATIC H.P.
(printed if XMSNIND = 1.0)

XMSN SIZED AT ______ PERCENT OF AUX. PROPULSION CRUISE POWER REQUIRED AT V_C = ______ KT.
H_C = ______ FT., TEMP., = ______ DEG.F.
(printed if ESCIND = 2.0 and XMSNIND = 2 or 3)

AUXILIARY INDEPENDENT PROPULSION DRIVE SYSTEM RATING
(printed if AUXIND = 3 or 4, AIPIND = 2 ENGIND = 0)

Depending on the transmission sizing option chosen (XMSNIND) and the results of the sizing one of the following four statements will be printed:

> XMSN SIZED AT ______ PERCENT OF TOTAL AUXILIARY
> INDEPENDENT ENGINE INSTALLED POWER
> MAX. STANDARD S.L. STATIC H.P.
> (printed if AIPIND = 2, ENGIND = 0, and XMSNIND = 1.0)

> XMSN SIZED AT ______ PERCENT OF MAX. AUXILIARY
> INDEPENDENT ENGINE POWER AVAILABLE
> AT H = _______ FT., TEMP. = _______ DEG.F.
> (printed if AIPIND = 2, ENGIND = 0, ESCIND = 1 and XMSNIND = 2 or 3)

> XMSN SIZED AT ______ PERCENT OF MAX. AUXILIARY
> INDEPENDENT ENGINE POWER AVAILABLE IN CRUISE
> AT V_C = _____ KT., H_C = _____ FT., TEMP. = _____ DEG.F.
> (printed if AIPIND = 2, ENGIND = 0, XMSNIND = 2 or 3 and FIXIND = 0.0)

> XMSN SIZED AT ______ PERCENT OF AUXILIARY PROPULSION
> CRUISE POWER REQUIRED AT V_C = _______ KT.
> H_C = _______ FT., TEMP. = _______ DEG.F.
> (printed if AIPIND = 2, ENGIND = 0, XMSNIND = 2 or 3 and FIXIND = 1.0)

6.1.3.5 Aerodynamics Data

Single and Tandem Rotor Helicopter

TOTAL EFFECTIVE FLAT PLATE AREA
TOTAL WETTED AREA
MEAN SKIN FRICTION COEFF.

DRAG BREAKDOWN

> WING FE
> FUSELAGE FE
> FORWARD (MAIN) ROTOR PYLON FE
> AFT ROTOR PYLON FE
> MAIN ROTOR HUB(s) FE
> TAIL ROTOR HUB FE
> VERTICAL TAIL FE
> HORIZONTAL TAIL FE
> PRIMARY ENGINE NACELLE FE
> AUXILIARY INDEPENDENT CRUISE ENGINE NACELLE FE
> AUXILIARY INDEPENDENT CRUISE ENGINE NACELLE STRUT FE
> INCREMENTAL FE

AERODYNAMIC COEFFICIENTS

A5
A6
A7
A8
A9
WING LIFT EFFICIENCY FACTOR
VERTICAL TAIL LIFT EFFICIENCY

6.1.4 Mission Performance Data

Two types of output are possible. If the OPTIONAL PRINT INDICATOR = 0, a standard printout will occur. If the indicator is input as 1, a detailed printout will occur. This will include all data printed in the standard printout plus additional information.

6.1.4.1 Standard Printout

The mission performance data is printed out by segment in chronological sequence. Up to 15 columns of data are printed out depending upon the segment. For all segments, the following information is printed:

t: time in hours

R: range in nautical miles

W_f: weight of fuel used in pounds

W: aircraft weight in pounds

h: altitude in feet

TAS: the true airspeed in knots

Primary Turb. Temp: the primary engine turbine temperature

PRIMARY ENGINE CODE: a code letter which designates the condition governing the engine performance:

P = power (or thrust) required

T = turbine temperature (engine rating)

W = fuel flow limit

N1 = gas generator shaft rmp limit

C = compressor (N_I/θ_1) limit

N2 = output shaft RPM limit

Q = torque limit

PRIMARY ENG. PEHF: The primary engine horsepower fraction. This is the ratio of power being used at any altitude, Mach number condition to the maximum power available at that condition.

In addition, the following data is printed out in different segments:

AUX. TURB. TEMP: The auxiliary independent engine turbine temperature.

AUX. ENG. CODE: A code letter which designates the condition governing the auxiliary independent engine performance: (code is same as for primary engines).

AUX. ENG. PEHF: The auxiliary independent engine thrust or horsepower fraction. This is the ratio of thrust or power being used at any altitude, Mach number condition to the maximum thrust, or power available at that condition.

AUX. ENG. FUEL FLOW: Auxiliary independent engine time rate of fuel consumption in pounds per hour.

TEMP DEG. (F) Ambient temperature °F, printed out in Taxi, and Takeoff, Hover, Landing only.

TOTAL FUEL FLOW: Total time rate of fuel consumption (primary plus auxiliary independent engines) in pounds per hour.

T/W: The thrust-to-weight ratio (printed out in takeoff, hover, and landing).

FM: Main rotor overall hover figure of merit (for a tandem rotor configuration, this includes rotor/rotor interference) (printed out in takeoff, hover and landing).

BHP: Total power required (printed out in takeoff, hover, and landing, climb, cruise, descent, and loiter).

CT:	Main rotor thrust coefficient (printed out in takeoff, hover, and landing, climb, cruise, descent, and loiter).
CT/SIGMA:	CT/main rotor solidity (printed out in takeoff, hover, and landing).
EAS:	The equivalent airspeed in knots (printed out in climb, cruise, descent, and loiter).
MU:	Main rotor advance ratio (printed out in climb, cruise, descent, and loiter).
CT PRIME/SIGMA:	Main rotor cruise lift coefficient/main rotor solidity (printed out in climb, cruise, descent, and loiter).
ALPHA D/L:	Angle of total rotor thrust (lift plus propulsive force) vector with respect to a line perpendicular to the A/C flight path (printed out in climb, cruise, descent and loiter).
NMPP:	The specific range in nautical miles per pound (printed out in cruise).
GAMMA:	The flight path angle in degrees (printed out in climb and descent).
R/C:	Rate of climb in feet per minute (printed out in climb).
R/S:	Rate of descent in feet per minute (printed out in descent).

6.1.4.2 Detailed Printout

In addition to the data printed above, the following data (unless noted otherwise) will be printed in takeoff, hover, and landing, climb, cruise, descent, and loiter segments if the OPTIONAL PRINT INDICATOR = 1:

VRC RHP:	Vertical rate of climb rotor horsepower (printed out only in takeoff, hover and landing).
FMI:	Isolated main rotor hover figure of merit (printed out only in takeoff, hover, and landing).

TOTAL FUEL FLOW:	Total fuel consumption (primary + auxiliary independent engines) - lb/hr (printed out only in loiter).
M. ROTOR VTIP:	Main rotor tip speed - feet per second
M. ROTOR RHP:	Main rotor horsepower (no losses)
T. ROTOR VTIP:	Tail rotor tip speed - feet per second
T. ROTOR RHP:	Tail rotor horsepower (no losses)
PRIM. ENG. FUEL FLOW:	Primary engine fuel consumption - lb/hr
AUX. ENG. FUEL FLOW:	Auxiliary independent engine fuel consumption - lb/hr
ROTLIM CODE:	A code letter which designates whether main rotor has exceeded the rotor limits input to the program. A = Within input rotor limits E = Rotor limits exceeded
DELCDM:	Compressibility drag coefficient increment to rotor profile power. In hover, it is a function of rotor C_T/σ and V_{TIP}. In cruise it is a function of rotor C_T/σ and advancing blade tip Mach number (only printed out when a rotor "cycle" is input).
CPPRO:	Rotor profile power coefficient (only printed out when a rotor "cycle" is input).
CPIND:	Rotor induced power coefficient (only printed out when a rotor "cycle" is input).
CDO:	Rotor profile drag (total) coefficient (only printed out when a rotor "cycle" is input).
PROP VTIP:	Propeller tip speed - ft/sec.
BHP AUX:	Auxiliary propulsion power required (not printed out in takeoff, hover, and landing).
ETAP PROP:	Propeller cruise efficiency

TAUX/T:	Ratio of auxiliary propulsion thrust to total configuration thrust required.
AUX. ENG. FUEL FLOW:	Same as noted earlier
AUX. TURB. TEMP:	
AUX. ENG. CODE:	
AUX. ENG. PEHF:	
AUX. ENG. BHP OR THRUST:	Auxiliary independent engine power (if ENGIND = 0, horsepower required printed out. If ENGIND = 1, thrust required printed out).
CPPAR:	Rotor parasite power coefficient (only printed out when a rotor "cycle" is input).
CPNUD:	Rotor nonuniform downwash power coefficient (only printed out when a rotor "cycle" is input).
DELCDS:	Retreating blade stall coefficient increment to rotor profile power (only printed out when a rotor "cycle" is input).
CXR:	Rotor propulsive force coefficient
J	Propeller advance ratio
CP	Propeller power coefficient
CT	Propeller thrust coefficient
CLW	Wing lift coefficient
CDW	Wing profile drag coefficient
RN	Fraction of total lift carried by rotor

6.1.4.3 Headings

At the beginning of each segment, a printout will identify the segment data which follows. The following messages can be printed:

a. TAXI FOR ____ HRS. AT GROUND IDLE ENGINE RATING

b. TAKEOFF, HOVER, OR LAND AT T/W = _____ FOR _____ HRS.

or: TAKEOFF, HOVER, OR LAND AT PEHF = ____, FOR ____ HRS.

c. CLIMB TO ____ FT. WITH MAX R/C AT ____ ENGINE RATING

CLIMB TO ____ FT. WITH CONSTANT EAS AT ____ ENGINE RATING

CLIMB TO ____ FT. WITH CONST. MACH NO. AT ____ ENGINE RATING

CLIMB TO ____ FT. WITH CONSTANT TAS AT ____ ENGINE RATING

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH MAX. R/C AT ____ ENGINE RATING, MAXIMUM ALT. ____ FT.

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH CONSTANT EAS AT ____ ENGINE RATING, MAXIMUM ALT. ____ FT.

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH CONST. MACH NO. AT ____ ENGINE RATING, MAXIMUM ALT. ____ FT.

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH CONSTANT TAS AT ____ ENGINE RATING, MAXIMUM ALT. ____ FT.

d. CRUISE AT ____ ENGINE RATING

CRUISE AT ____ KNOTS TAS LIMITED BY ____ ENGINE RATING

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF ____ KNOTS

CRUISE AT SPEED FOR 99 PERCENT BEST RANGE WITH HEADWIND OF ____ KNOTS

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF ____ KNOTS, CONSTANT W/DELTA = ____

e. DESCEND TO H = ____ FT AT CONSTANT EAS

DESCEND TO H = ____ FT AT CONSTANT TAS

DESCEND TO H = ____ FT AT CONSTANT TAS (SPIRAL DESCENT PATH)

DESCEND TO H = ____ FT AT CONSTANT EAS (SPIRAL DESCENT PATH)

DESCEND TO H ____ FT AT CONSTANT MACH NO.

DESCEND TO H = ____ FT AT CONSTANT MACH NO. (SPIRAL DESCENT PATH)

DESCEND TO H = ____ FT., R = ____ NM AT CONSTANT EAS

DESCEND TO H = ____ FT., R = ____ NM AT CONSTANT MACH NO.

DESCEND TO H = ____ FT., R = ____ NM AT CONSTANT TAS

f. LOITER FOR ____ HRS.

g. CHANGE FUEL, ADD ____ LB

CHANGE FUEL, REMOVE ____ LB

h. CHANGE PAYLOAD, ADD ____ LB

CHANGE PAYLOAD, REMOVE ____ LB

i. TRANSFER ALTITUDE TO ____ FT

After the complete mission history has been printed, the following fuel summary will be printed:

MISSION FUEL REQUIRED =

RESERVE FUEL REQUIRED =

TOTAL FUEL REQUIRED =

NOTE: If segments 1 through 6 are used for reserve fuel calculations, headings a. through f. will be followed by the statement FOR RESERVE FUEL.

6.1.4.4 General Performance Data

If the General Performance Mission (SGTIND = 11) is issued, a fixed heading consisting of 7 constant parameters, followed by a 49 variable list will be printed.

The fixed constants are:

GROSS WEIGHT = ____ W/DELTA = ____

ALTITUDE = ____ DELTRTH = ____

TEMPERATURE = ____ DELTA = ____

THETA = ____

where DELTA = P/P_o

THETA = T/T_o

DELTRTH = $\delta\sqrt{\theta} = \frac{P}{P_o} \frac{T}{T_o}$

The 49 variables will be printed out according to the input velocity increment ΔV – (LOC 4230). These variables consist of:

SHP/DELRTH	=	RATIO OF SHAFT HORSEPOWER TO PRESSURE RATIO MULTIPLIED BY SPARE ROOT TEMPERATURE RATIO.
SHPI/DELRTA	=	RATIO OF AUXILIARY INDEPENDENT ENGINE SHAFT HORSEPOWER TO PRESSURE RATIO MULTIPLIED BY SQUARE ROOT TEMPERATURE RATIO.
M. ROTOR RHP/DELRTH	=	RATIO OF MAIN ROTOR HORSEPOWER TO PRESSURE RATIO MULTIPLIED BY SQUARE ROOT TEMPERATURE RATIO.
T. ROTOR RHP/DELRTH	=	RATIO OF TAIL ROTOR HORSEPOWER TO PRESSURE RATIO MULTIPLIED BY SQUARE ROOT TEMPERATURE RATIO.
AUX. PROP RHP/DELRTH	=	RATIO OF AUXILIARY PROPULSION ROTOR HORSEPOWER TO PRESSURE RATIO MULTIPLIED BY SQUARE ROOT TEMPERATURE RATIO.
CONFIG L/DE	=	RATIO OF LIFT TO EFFECTIVE DRAG FOR THE ENTIRE CONFIGURATION OF AIRCRAFT.
ROTOR L/DE	=	RATIO OF ROTOR LIFT TO EFFECTIVE DRAG FOR THE ROTOR ONLY.
ROTOR (L/DE)I	=	RATIO OF ROTOR LIFT TO EFFECTIVE DRAG FOR THE INDEPENDENT (TANDEM) ROTOR ONLY.
WING L/DE	=	RATIO OF WING LIFT TO EFFECTIVE DRAG
R_N	=	FRACTION OF TOTAL LIFT CARRIED BY ROTOR.

The remaining variables are printed out in the General Performance segment regardless of the value of the optional print indicator (LOC 0002).

TAS	M. ROTOR VTIP	CPPRO	J
MU	M. ROTOR RHP	CPIND	CP
CT/SIGMA	T. ROTOR VTIP	CPPAR	CT
CT	T. ROTOR RHP	RPNUD	CLW
ALPHA D/L	PROP VTIP	EDO	CDW
BHP	BHP AUX	DELCDS	AUX ENG PETF
BHPI	ETAP PROP	DELCOM	
T/W	TAUX/T	CXR	
FM	TOTAL FUEL FLOW	SPEC RANGE (NMPP)	
FMI	PRIM ENG FF	AUX ENG FF	
EAS	PRIM ENG PEHF	AUX ENG PEHF	

EPSILON

C_T

(Q/L)/D

7.1 COMMENTS ON PROGRAM USAGE

Following are a list of rules and suggestions for using the program:

7.1.1 Rules

1. Do not use descent option RMAXND = 0 unless preceded by a cruise.

2. Do not input a turbofan or turbojet engine cycle for the primary engines.

3. $(T/W)_D$ (LOC 0228) <u>must</u> <u>always</u> be input. This is the basic configuration design thrust-to-weight ratio. It is used to establish the basic configurations download for calculation of both hover and low forward speed performance.

4. If FIXIND = 0 and FIXINDI = 0.1, locations 0234 - 0241 <u>must be</u> input to allow sizing of the auxiliary independent engines.

5. If FIXIND = 1 and ESCIND = 1 only fixed size auxiliary independent engines (FIXINDI = 0.0) <u>may be</u> input.

6. If OPTIND = 2, the helicopter parasite drag should be input as two terms. The wing (if there is one) profile drag coefficient is input to the table of C_{DWi} versus C_L, and all other component contributions are input by means of the term F_e (LOC 0316). The terms $C_{D_{AP}}$, $C_{D_{FP}}$, $C_{D_{CSMR}}$, $C_{D_{SHMR}}$, $C_{D_{CSTR}}$, $C_{D_{SHTR}}$, C_{D_N}, $C_{D_{NI}}$, $C_{D_{NS}}$, $C_{D_{VT}}$, and $C_{D_{HT}}$. K_{HPIM}, K_{HPIT}, K_N, K_{NI}, K_{NS}, K_F, K_{VT}, and K_{KT} are not used in OPTIND = 2. If the option indicator is 1, all terms and factors may be used.

7. If OPTIND = 2, all necessary green colored locations on the input sheets should be filled in, regardless of any footnote messages.

8. If cruise is followed by descent with RMAXND = 0, the cruise step size (LOC. 0771 - 0780) should not be less than 10 to 15 nautical miles. This is necessitated by the fact that a table of cruise conditions is compiled during cruise to use in the determination of the starting point for descent. This table consists of 10 points. The cruise step size therefore must be sufficiently large to ensure that the total of nine steps in range is greater than the range required for the following descent. A cruise step size which is too small will lead to termination of the case with the printout:

*** ERROR *** THE RANGE NECESSARY TO DESCEND IS GREATER THAN THE RANGE OF THE TABLE CALCULATED IN CRUISE. THIS MAY BE DUE TO A DELTA R IN CRUISE WHICH IS TOO SMALL.

9. At present do not use SGTIND = 7 with OPTIND = 1 unless a sufficiently large S_F is input to completely refuel the aircraft. Missions employing change of fuel can be analyzed by running separate cases, a new case each time the fuel is changed. The aircraft can be separately sized for each case and compared manually.

10. The value for payload which is input (LOC. 2604) should be the payload at initial takeoff.

11. If KPRINT (LOC. 0002) = 0, ambient temperature will only be printed out in TAXI (SGTIND = 1.), and General Performance (SGTIND = 11.)

7.1.2 <u>Suggestions</u>

1. Input locations 0005 - 0022 are arranged in a sequential order (1st and 2nd order size trend and propulsion indicators) which allows configuration types to be input in a logical "building block" manner. Use of this arrangement facilitates the input of data. For example if the user wishes to input a single rotor auxiliary independent engine compound helicopter, the following input sequence follows:

   a) Input CNFIND = 1 (single rotor helicopter)

   b) Input AUXIND = 4 (compound helicopter)

   c) Since a compound helicopter has wings, input desired wing sizing options (S_WIND and b_WIND).

   d) Input AIPIND = 2 (auxiliary independent engines)

   e) Input desired type of auxiliary independent engine (ENGIND)

   f) Input those options pertaining only to single rotor helicopters (TRDIND, TRSIND, VTFIND, HTIND, and MRPIND)

2. If nonstandard atmosphere is required only for constant altitude segments, such as loiter, cruise, and takeoff, the table of temperature ratio versus altitude need not be filled in. The nonstandard atmosphere may be obtained by use of ATMIND = 1.

3. If it is desired to run OPTIND = 2 for a helicopter which has previously been sized in a separate case, the drag

7.2 DISCUSSION OF PROGRAM TOLERANCES

The tolerances tabulated in Table 7-1 represent the accuracy required of iterated values calculated at certain points in the program. Whenever the values of the quantities named in Table 7-1 become less than the value quoted, the iterating calculation is terminated.

TABLE 7-1. PROGRAM TOLERANCES				
SYMBOL	VALUE	VARIABLE BEING CALCULATED	SITUATION IN PROGRAM	FUNCTION OF TOLERANCE
TOL	0.01	W_G, Gross Weight	Main Control Loop	When the quantity $\lvert 1-(W_f)_A/(W_f)_R \rvert \leq$ TOL, the fuel required and available are considered to be sufficiently close and the sizing calculation is terminated.
$\Delta\gamma$	0.1°	γ, Flight Path Angle	Climb & Descent Sub routines	Determines flight path angle to within 0.1°
$\frac{\Delta BHP}{BHP_A}$	0.01	$\frac{BHP_A - BHP_R}{BHP_A}$	Cruise	The cruise speed is set when BHP_R is within 0.01 BHP_A
ΔB	0.01	$\frac{B_1 - B_2}{B_2}$	CRSIND = 1	$\frac{B_1 - B_2}{B_2}$ is used to adjust ΔV to expedite computation. If $\frac{B_1 - B_2}{B_2}$ becomes less than ΔB, BHP_R always exceeds BHP_A
$\frac{\Delta(X_M/\ell_B)}{(X_M/\ell_B)_c}$	0.01	$\frac{(X_M/\ell_B)-(X_M/\ell_B)_c}{(X_M/\ell_B)_c}$	Main control loop	The main rotor position is determined when X_M/ℓ_B is within 0.01 $(X_M/\ell_B)_c$
$\frac{\Delta D_{TR}}{D_{TR_I}}$	0.01	$\frac{D_{TR} - D_{TR_I}}{D_{TR_I}}$	Size trends subroutine	The tail rotor diameter is determined when D_{TR} is within 0.01 D_{TR_I}.
$\frac{\Delta\sigma TR_1}{\sigma_{TR}}$	0.01	$\frac{\sigma_{TR_1}-\sigma_{TR}}{\sigma_{TR}}$	Main control loop	The tail rotor solidity is determined when σ_{TR}, is within 0.01 σ_{TR}.
R_{TOL}	5 nm	R, Range	Descent Sub routine	If the range at the end of descent is within R_{TOL} nm of R_{max} the calculation terminates.

7.3 SAMPLE CASES

To illustrate the use of the program, five sample cases have been run and the output included here.

The first case, first run, is for a single-rotor compound helicopter with auxiliary independent cruise propulsion (T/Shaft - Propeller). This case illustrates main rotor (diameter and solidity) sizing, wing sizing for maneuver conditions, auxiliary independent engine sizing, tail rotor solidity sizing to meet hovering turn requirements, vertical tail area sizing based on tail rotor loss (in cruise) criteria, and the use of a drag trend. The primary engines and drive system are sized to meet specified takeoff and cruise requirements. The second run of Case No. 1 is identical to Run 1, except the helicopter is sized for weights only.

The second case, run 1, is for a tandem rotor winged helicopter. It illustrates the use of the component drag buildup option, fuselage sizing based on specified rotor overlap and cabin dimensions, aft rotor pylon sizing based on an input gap/stagger ratio, wing sizing for maneuver conditions, and main rotor (diameter and solidity) sizing. The primary engines and drive systems are sized to meet specified takeoff and cruise requirements. The second run of Case 2 is identical to Run 1, except the print option is for standard print, eliminating specific details.

The third sample case, run 1, is for a helicopter which has two contra-rotating, coaxial, three-bladed rigid rotors. Lift offset is employed on each rotor disc to increase lift and maintain roll trim. The need for a conventional tail antitorque rotor is eliminated by the coaxial arrangement. Two auxiliary fuselage mounted fans driven from the primary engines are used to provide propulsive force at high speeds. This case illustrates the use of the rotor L/D_e (Type II) rotor map input (ROTIND = 4) and the sizing of a helicopter without a tail anti-torque rotor (TRDIND = 0). Rotor solidity and disc loading are specified to size the rotor. The engines are sized to meet either the takeoff or cruise speed requirements, whichever are critical. The main rotor transmissions were sized for full installed torque and the auxiliary transmission used to drive the auxiliary fuselage mounted fans were sized for a high speed cruise torque requirements. Run 2 is identical to Run 1, except a torque limit was imposed on the auxiliary propulsion transmission instead of on the main and tail rotor transmission as in Run 1. Run 3 is identical to Run 2 except the drive system was rated for cruise. The drive system component (main, tail and auxiliary) power was obtained from the proportional split of the total sea level standard power.

The fourth sample case, Run 1, is for a helicopter which has two contra-rotating, coaxial, four-bladed rigid rotors. The need for a conventional tail anti-torque rotor is eliminated by the coaxial arrangement. Two auxiliary fuselage mounted propellers driven from the primary engines are used to provide propulsive force at high speeds. Run 1 illustrates the use of the rotor L/D_E rotor map input (ROTIND = 5). The rotor is operated at maximum rotor L/D_E with T_{AUX}/T as output. The program accepts a tip velocity schedule which consists of a mix between the advancing blade tip Mach number and the tip velocity. The helicopter is sized without a tail anti-torque rotor (TRDIND = 0). Rotor solidity and disc loading are specified to size the rotor (RDMIND = 2). The engines are sized to meet the takeoff requirements (ESCIND = 1). The main, tail and auxiliary drive system ratings are specified at a fraction of the power required to hover or cruise at design conditions. The more critical of the two conditions is selected.

In Run 1 when $T_{AUX}/T = 1000.$ the auxiliary propulsion schedule (locations 1671 - 1692) is followed directly as input. Run 2 is identical to Run 1 except for the L/D_E rotor map input (ROTIND = 6.) In Run 2 the rotor is operated at maximum configuration L/D_E with T_{AUX}/T as output. Run 3 is similar to Run 2 with changes only in $\frac{N_{II}}{N_{IIMAX}}$ and T_{AUX}/T. The program assumes the V_{TIP} schedule is in V_{TIP} only (locations 1269 - 1278). Also, the propulsive thrust provided by auxiliary propulsion at the specified condition for engine sizing follows the Auxiliary Propulsion Schedule in locations 1671 - 1692. Above that μ the maximum L/D_E is used.

The fifth sample case is for a single-rotor helicopter including wings only. This case illustrates wing sizing for maneuver conditions, main rotor disc loading sizing, tail rotor solidity sizing to meet hovering turn requirements, and the use of the General Performance Segment (SGTIND = 11). The primary engines are sized to meet takeoff requirements only.

7.3.1 Single Rotor Compound Helicopter (Auxiliary Independent Engines)

The design mission profile is illustrated in Figure 7-1. All the inputs are discussed for this case. The engine and rotor cycles are discussed only in sample case No. 1. A complete copy of the program printout follows the description of the input.

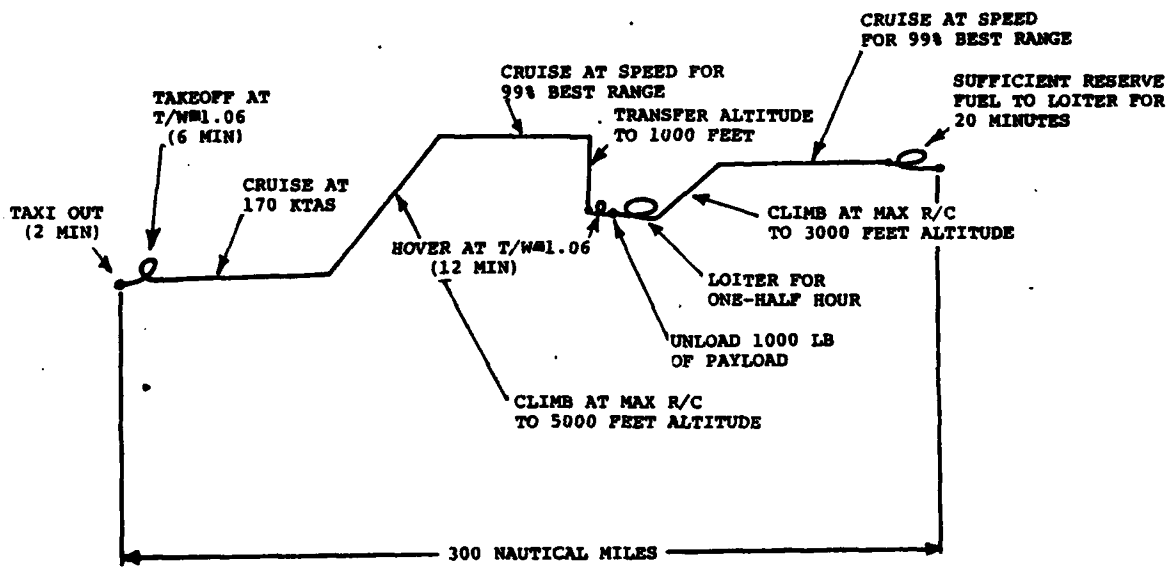

Figure 7-1. Design Mission - Sample Case No. 1

SAMPLE CASE NO. 1

GENERAL INFORMATION SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
OPTIND	0001	1.0	Sizing run
OPTIONAL PRINT	0002	1.0	Detailed printout desired
DRGIND	0003	2.0	GW/Fe Drag trend utilized
OSWIND	0004	0	User inputs Oswald efficiency factor
CNFIND	0005	1.0	Single-rotor helicopter
AUXIND	0006	4.0	Compound helicopter
RDMIND	0007	4.0	Main rotor diameter sized based on input disc loading; solidity sized based on input C_T/σ
FIXIND	0008	1.0	Program sizes primary engines
ROTIND	0009	1.0	Short form rotor performance method used
S_WIND	0010	3.0	Wing area sized by maneuver conditions
b_WIND	0011	1.0	Wing span sized based on input wing span/rotor diameter ratio
AIPIND	0012	2.0	Independent auxiliary engines
ENGIND	0013	0	Turboshaft auxiliary independent engines
FIXINDI	0014	1.0	Program sizes auxiliary independent engines

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
TRDIND	0015	1.0	Tail rotor diameter sized based on tail rotor/main rotor diameter trend
TRSIND	0016	2.0	Tail rotor solidity sized based on input C_T/σ
VTFIND	0017	2.0	Vertical Fin area sized to meet configuration anti-torque requirements upon loss of tail rotor
HTIND	0018	2.0	Horizontal tail volume coefficient input
MRPIND	0019	0	Main rotor position (on fuselage) input by user
ESCIND	0022	2.0	Primary engines sized for either takeoff or cruise
WG_O	0023	25000	First guess at design gross weight
h_O	0024	0	Start altitude — Normally 0 except for partial mission analysis
R_O	0025	0	Starting range — Normally 0 except for partial mission analysis
t_O	0026	0	Starting time — Normally 0 except for partial mission analysis
h_{OPT}IND	0027	0	Cruise at specified altitudes
M_{MO}	0028	0.33	Maximum operating Mach number
V_{MO}	0029	220	Maximum operating EAS knots
V_{DIVE}	0030	220	Design dive speed, knots EAS

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
M_{LF}	0031	3.5	Maneuver load factor	
K_1	0032	1.0	Factor on mission fuel burned to give reserve fuel, i.e., 1.1 would give 10 percent reserves	
δW_f	0033	0	Fixed fuel increment for reserves or other use	
K_{FF}	0034	1.05	Increase basic engine SFC by 5 percent	
SGTIND	0035	1.0	Taxi	Sequence of Design Mission
	0036	2.0	Takeoff	
	0037	4.0	Cruise	
	0038	3.0	Climb	
	0039	4.0	Cruise	
	0040	9.0	Transfer altitude	
	0041	2.0	Takeoff	
	0042	8.0	Change payload	
	0043	6.0	Loiter	
	0044	3.0	Climb	
	0045	4.0	Cruise	
	0046	60.0	Loiter (reserve fuel)	
	0047	100.0	End of case	

HELICOPTER DIMENSIONAL INFORMATION SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
b_W/D	0103	0.5	Wing span/main rotor diameter ratio
$(t/c)_R$	0105	0.20	Wing root thickness/ chord ratio
$(t/c)_T$	0106	0.12	Wing tip thickness/ chord ratio
$\Lambda_{c/4}$	0107	0	Quarter-chord mean sweep angle, degrees
λ	0108	0.5	Wing taper ratio (tip chord/root chord)
C_F/C	0109	1.0	Ratio of download al-leviating flap chord to wing chord (1.0 signi-fies a fully tilting wing)
h'/h_F	0110	0.20	Ratio of vertical wing position on fuselage as a fraction of fuselage height
C_{L_D}	0111	0.8	Wing design lift coef-ficient
AR_{HT}	0112	4.0	Horizontal tail aspect ratio
ℓ_{TH}'	0113	1.15	Ratio of horizontal tail moment arm to main rotor radius
$(t/c)_{HT}$	0114	0.12	Horizontal tail thick-ness/chord ratio
$\overline{V}_H$	0115	0.0162	Horizontal tail volume coefficient
λ_H	0116	0.5	Horizontal tail taper ratio
$\Delta S_{wet}/S_F$	0120	0	Fuselage wetted area ratio

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ΔS_{wet}	0121	0	Incremental fuselage wetted area
h_F	0122	7.0	Fuselage height
W_F	0123	6.5	Fuselage width
$(\ell/d)_P$	0124	1.3	Fineness ratio of nose
$(\ell/d)_T$	0125	1.0	Fineness ratio of tail
ℓ_C	0126	12.	Constant diameter section length
ℓ_{RW}	0127	0	Length of ramp well
X_M/ℓ_B	0128	0.55	Main rotor position aft of the nose as a fraction of main fuselage length
$\ell_{TB}/d_{\overline{TB}}$	0129	5.0	Fineness ratio of tail boom
$d_{\overline{TTB}}/d_{\overline{TB}}$	0130	0.3	Ratio of average tail boom tip diameter to average tail boom diameter
$k_{T.\ STING}$	0131	1.1	Tail boom extends aft of the tail rotor disc by 10 percent of the tail rotor radius
λ_{VT}	0136	0.45	Vertical tail taper ratio
$(t/c)_{VT}$	0137	0.15	Vertical tail thickness/chord ratio
ζ_{VT}	0138	0.80	Vertical tail fin/tail rotor overlap ratio
K_Z	0139	0.85	Vertical position of the tail rotor center (relative to the vertical fin root chord) as a fraction of tail rotor radius

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$C_{L_{DES}}$	0140	0.5	Vertical tail fin design lift coefficient
V_{DES}	0141	180	Vertical tail fin sized to provide aircraft directional stability at 180 kts in event of tail rotor loss
Z_1	0142	0.035	Primary engine nacelle constants
Z_2	0143	2.0	
Z_3	0144	0.078	
ℓ_{AIP}/ℓ_C	0145	.1	Ratio of air induction system length to engine length (primary engines)
Z_4	0146	0.035	Auxiliary independent engine nacelle constants
Z_5	0147	2.0	
Z_6	0148	0.078	
ℓ_{AIA}/ℓ_{EA}	0149	.0	Ratio of air induction system length to engine length (auxiliary engines)
$\Delta S/S_{STR}$	0150	.0	Ratio of incremental auxiliary independent engine nacelle strut planform area to auxiliary independent engine nacelle strut planform area
b_{ns}/d_{NI}	0151	.1	Ratio of auxiliary independent engine nacelle strut span to nacelle diameter
$(t/c)_{RF}$	0152	0.40	Forward rotor pylon root thickness/chord ratio
$(t/c)_{TF}$	0153	0.20	Forward rotor pylon tip thickness/chord ratio

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
AR_{FP}	0154	0.5	Forward rotor pylon aspect ratio
λ_{FP}	0155	0.4	Forward rotor pylon taper ratio
h_{p_1}	0156	3.0	Forward rotor pylon height

MAIN ROTOR DIMENSIONAL DATA SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ROTOR CYCLE NO.	0171	3	Rotor blade section aerodynamic characteristics selection
N_R	0172	1.0	Number of rotors
W/A	0173	11.0	Disc loading
b_{MR}	0176	4.0	Number of blades/main rotor
θT_{MR}	0177	-9.0	Main rotor twist (deg)
$X_{C_{MR}}$	0178	0.25	Main rotor blade cutout as a fraction of radius
X_{MR}	0179	0.075	Main rotor blade attachment point as a fraction of radius
$(t/c)_{.25R}$	0180	0.10	Rotor blade thickness/chord at 25 percent radius
V_{TIP}	0181	725	Main rotor tip speed
$(C_T/\sigma)_H$	0182	0.12	Rotor "lift coefficient" for hover sizing solidity
T/W	0183	1.06	Rotor design thrust/weight ratio
$V_{KT}(c)$	0184	165	
$h_c(c)$	0185	3000	Cruise flight conditions for sizing rotor solidity
ΔT_{IN_C}	0186	43.2	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$(C_T/\sigma)_{CR}$	0187	0.110	Rotor "lift coefficient" for sizing rotor solidity in cruise flight
$g_{REQM'T}$	0188	1.75	Total g requirement, helicopter must satisfy
g (ROTOR)	0189	1.35	Maneuver g's carried by main rotor
N (ROTOR LOADING)	0190	1.00	Rotor lift/GW for 1g cruise flight rotor solidity sizing
$V_{CEH}1$	0191	1.53	Main rotor vertical rate-of-climb efficiency factors
$V_{CEH}2$	0192	0	
$K_{P_{CLIMB}}$	0193	0.85	Helicopter forward flight climb efficiency

TAIL ROTOR DIMENSIONAL DATA SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
b_{TR}	0203	5.0	No. of blades/tail rotor
θT_{TR}	0204	-4.0	Tail rotor twist (deg)
$X_{C_{TR}}$	0205	0.3	Tail rotor blade cutout as a fraction of radius
X_{TR}	0206	0.075	Tail rotor blade attachment point as a fraction of radius
V_{TTR}	0207	690	Tail rotor tip speed
$(C_T/\sigma)_{DES}(H)$	0208	0.17	Tail rotor limiting design rotor "lift coefficient"
$\dot{\psi}$	0209	0.30	Helicopter yaw acceleration, rad/sec^2
$\ddot{\psi}$	0210	0.75	Helicopter yaw rate, rad/sec
$C_{T_G}/C_{T_{NET}}$	0211	1.00	Vertical tail fin/tail rotor sideload ratio (when input as 1.00, program calculates a value of $C_{T_G}/C_{T_{Net}}$ based on tail fin/rotor geometry)

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$\bar{C}$	0212	0.72	Tail rotor induced velocity ratio for a pusher type tail rotor (see fig. 4-21, sect. 4.8)
K_{ZZZ}	0213	1.00	Single rotor helicopter yaw moment of inertia trend adjustment factor (nominally = 1.00)
$g_{MR/TR}$	0214	1.0	Gap between main and tail rotor disc (ft)
K_{TRS}	0215	1.05	Tail rotor solidity increased 5 percent over that dictated by hovering turn requirements
$C_{L_{FIN}}$	0216	0	Vertical tail fin operating cruise lift coefficient

PRIMARY ENGINE SIZING INFORMATION SHEET

PRIMARY ENGINE CYCLE NO.	0217	1.761	Primary engine selection
N_P	0219	2.0	No. of primary engines
XMSNIND	0220	2.0	Drive system rated at power required to hover or cruise (more critical of the two conditions selected by program)
SHP_{MRX}/SHP^*_{MR}	0221	1.0	Main rotor drive system is rated at 100 percent of main rotor design power
$K_{ALTPAYL}$	0222	1.	Ratio of alternate payload increment to design payload (used in XMSN sizing)
η_T	0223	0.97	Transmission efficiency
ΔSHP_{ACC}	0224	100	Accessory power losses
SHP_{TRX}/TRP^*	0225	1.0	Tail rotor drive system is rated at 100 percent of tail rotor design power

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
SHP_{AUX}/SHP^*_{AUX}	0226	1.0	Aux propulsion drive system is rated at 100 percent of aux propulsion design power
$h_{TO}(H)$	0227	4000	Design point hover altitude (engine sizing)
$(T/W)_D$	0228	1.06	Configuration design point hover thrust/weight ratio
$\Delta T_{INTO}(H)$	0229	50.3	Increment in ambient temperature for engine sizing at takeoff conditions (°F)
$(N_{II}/N_{IIMAX})TO$	0230	1.105	Main rotor operating at 100 percent of hover tip speed (725 fps); as input in location 0181, i.e. $\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{TO}\left(\frac{N_{IIMAX}}{NII^*}\right) VT$ (LOC 0230)x(LOC 1223)x (LOC 0181) $= (1.105)\ (.905)\ (725)$ $= 725 = V_{T_{OPERATING}}$
N_{PSD}	0231	0	No. of engines inoperative at hover design point conditions
SHP_E/SHP^*	0232	0.95	Engines sized to permit operation in hover (OGE) at 95 percent of the maximum rated power
$(VR/_C)_D$	0233	.0	Design vertical rate of climb (ft/min) used in sizing primary engines in hover
POWIND	0234	2.	Normal engine rating
h_c	0235	3000	Design point (cruise) altitude (engine sizing)
V_c	0236	170	Design point cruise speed (engine sizing)

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ΔT_{INCE}	0237	43.2	Increment in ambient temperature for primary engine sizing at cruise condition (°F)
$(N_{II}/N_{IIMAX})c$	0238	1.105	Ratio of operating power turbine speed to maximum power turbine speed (input when sizing primary engines for cruise)
$(T_{AUX}/T_{TOT})c$	0239	0.75	75 percent of propulsive thrust provided by aux. propulsion at cruise conditions for engine sizing
$C_{L_{D_P}}$	0240	0.3	Wing operating lift coefficient at cruise conditions for engine sizing
$(N_{PSD})_C$	0241	0	No. of primary engines shut down during cruise (for engine sizing)
AUXILIARY INDEPENDENT ENGINE SIZING INFORMATION SHEET			
AUX PROPULSION ENGINE CYCLE NO.	0242	1.761	Auxiliary independent engine selection
N_P	0245	1.0	Helicopter has one aux. independent engine
POWIND	0246	2	Aux. independent engine sized to provide 75 percent of configuration propulsive thrust at NRP
$(N_{II}/N_{IIMAX})^i$	0247	1.105	Ratio of operating power turbine speed to maximum power, turbine speed (input when sizing primary engines for cruise)
No. of PROPS	0248	1	Number of propellers

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
PROPELLER DATA REQUIRED FOR COMPOUND HELICOPTER AUX PROPULSION INFORMATION SHEET			
V_{TAR}	0249	900	Propeller tip speed
DIA	0250	10	Propeller diameter
X_{AR}	0251	0.075	Propeller blade attachment point as fraction of radius
ηT_{AUX}	0252	0.97	Auxiliary drive system transmission efficiency
$\eta_p IND$	0253	0	"Point" propeller efficiencies specified for climb and cruise
η_{p3}	0254	0.82	Propeller efficiency in climb
$\eta_p{}^5$	0255	.8	Propeller propulsive efficiency for SGTIND=5
AF/Blade	0257	140	3-way propeller, 140 activity factor/blade
No. of Blades	0258	3	
No. of pairs in η_{p4} Table	0261	4	Number of pairs in prop/fan efficiency table, locations 0262-0271
Values of MACH	0262 0263 0264 0265	.0 .2 .4 .8	Mach number required during climb and/or descent
η_{p4}	0272 0273 0274 0275	.85 .83 .8 .78	Propeller propulsive efficiency for STGIND = 4, 6 tabular function of Mach number
HELICOPTER AERODYNAMICS INFORMATION SHEET			
(GW/Fe)	0312	1130	Drag trend constants derived from data such as illustrated by fig. 4-30, section 4-9
K_{FED}	0313	.555	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
e	0314	0.75	Wing "span loading" efficiency factor
TFEF	0315	1.0	Tail fin aspect ratio effectiveness factor (nominally = 1.0)
K_N	0323	.0	Primary nacelle multiplicative drag factor
K_W	0327	1.02	Wing multiplicative drag factor
$(Re/l)_i$	0328	$1.464(10^6)$	Mean Reynolds No./ft based on primary engine cruise sizing flight conditions
C_{l_α}	0329	6.28	Wing 2-D lift curve slope
No. of pairs in CL-Cd Table	0330	7.	Number of pairs input in locations 0331-0346
Clw(1)	0331	.0	Wing lift coefficient
Clw(2)	0332	.2	
Clw(3)	0333	.4	
Clw(4)	0334	.6	
Clw(5)	0335	.8	
Clw(6)	0336	1.	
Clw(7)	0337	1.4	
Cdwi(1)	0339	.006	Profile drag coefficient of wing at $Re=10^7$ (based on wing planform area)
Cdwi(2)	0340	.0062	
Cdwi(3)	0341	.007	
Cdwi(4)	0342	.008	
Cdwi(5)	0343	.0095	
Cdwi(6)	0344	.012	
Cdwi(7)	0345	.02	
No. of C_X/σ	0347	3.	Specifies number of C_X/σ values in table locations 0349-0353
No. of μ	0348	3.	Specifies number of values in table locations 0354-0360
Values of C_X/σ	0349	.0	Rotor propulsive thrust coefficient divided by main rotor solidity. Used in defining rotor limits
	0350	.5	
	0351	1.	

$$C_X/\sigma = \frac{\text{THRUST REQUIRED}}{\rho A N_R V_{TIP}^2 \sigma_{MR}}$$

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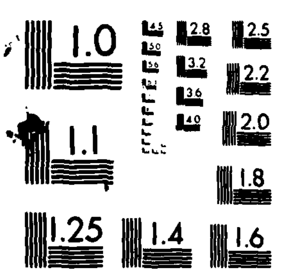

MICROCOPY RESOLUTION TEST CHART
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VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
	0354 0355 0356	.0 .5 1.	Rotor forward flight advance ratio $\mu = \frac{V_{FPS}}{V_{TIP}}$
Values of C_T/σ	0361 0362 0363	1. 1. 1.	Values of C_T/σ corresponding to $(C_X/\sigma)_1$ location 0349 and μ_1, μ_2, and μ_3.
	0368 0369 0370	1. 1. 1.	Values of C_T/σ corresponding to $(C_X/\sigma)_2$ location 0350 and μ_1, μ_2, and μ_3.
	0375 0376 0377	1. 1. 1.	Values of C_T/σ corresponding to $(C_X/\sigma)_3$ location 0351 and μ_1, μ_2, and μ_3.

HELICOPTER WEIGHT INFORMATION SHEET

W_{FE}	2602	2200	Weight of fixed equipment in lbs.
W_{FUL}	2603	450	Weight of fixed useful load in lbs.
W_{PL}	2604	2000	Weight of payload in lbs.
ΔW_{FC}	2605	100	Flight controls group incremental weights in lbs.
ΔW_P	2606	.0	Propulsion group incremental weight in lbs.
ΔN_{ST}	2607	.0	Structures group incremental weight in lbs.
RM_1	2608	.0	Wing relief as percentage of GW
W_I	2609	.0	Weight of inboard store
W_O	2610	.0	Weight of outboard store
d_i	2611	.0	Position of inboard underwing store (fraction of wing semi-span)

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
d_o	2612	.0	Positon of outboard underwing store (fraction of wing semi-span).
k_{CC}	2613	25.	Cockpit controls weight factor.
k_{RL}	2614	25.	Main rotor controls weight factor.
k_{SC}	2615	25.	Main rotor system controls weight factor.
k_{FW}	2616	.0	Fixed wing controls.
k_{TM}	2617	.0	Tilt mechanism weight factor.
k_{SAS}	2618	30.	Stability Augmentation System (SAS) weight factor. Usually in the range of 20-100 pounds.
k_{RCA}	2619	.18	Auxiliary rotor controls weight factor.
k_{SCA}	2620	25.	Auxiliary rotor system controls weight factor.
k_{MG}	2621	.0	Miscellaneous controls weight factor in CBS.
k_B	2622	125.	Body group weights factor.
ΔC.G.	2623	2.08	Helicopter cg travel (FT).
k_{LG}	2624	.04	Landing gear weight factor. Percentage of gross weight.
k_{MG}	2625	.8	Main landing gear weight factor.
k_{WW}	2626	.0	Detailed wing weight factor. This adjusts the constant 220 in $W_N = 220(k)^{.582}$ up or down depending on the complexity of the control surfaces.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_F	2627	1.	Wing unload factor. Entered as a fraction of design gross weight.
k_{WS}	2628	.0	Wing stores only weight trend factor.
k_{WP}	2629	2.06	Wing weight/area factor (psf).
k_{HT}	2630	2.	Horizontal tail unit weight in PSF.
k_{CLF}	2631	24.1	Crash load factor.
k_{NAC}	2632	1.	Primary cowling weight factor (PSF).
k_{AIP}	2633	.75	Primary air induction system weight factor.
k_{NACA}	2634	1.	Auxiliary cowling weight factor (PSF).
k_{AIA}	2635	.75	Auxiliary air induction system weight factor.
k_{NS}	2626	.0	Nacelle strut weight factor.
k_{PRB}	2637	44.	Primary rotor blade weight factor.
k_{RBF}	2638	2.2	Rotor type factor; hingeless for this example.
k_{PH}	2639	61.	Primary hub weight factor.
k_{amd}	2640	.286	Main rotor weight factor.
k_{BLFD}	2641	1.15	Blade fold weight factor. Input as a fractional part of the total rotor weight.
k_{TR}	2642	14.2	Tail rotor weight factor.
k_{AR}	2643	14.2	Auxiliary rotor weight factor. This is the average value for the rotor or propeller weight (LB), $W_R = 14.2\ a\ (k)^{.67}$.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{PA}	2644	1.	Auxiliary rotor multiplicative input power, expressed here as 100% input power.
k_{VTAR}	2645	1.	Auxiliary tail rotor multiplicative top speed factor here as 100% input speed.
k_{PDS}	2646	25.0	Primary drive system weight factor.
k_{PDSZ}	2647	3.	Primary drive system weight factor. Number of gears in system.
k_{TRDS}	2648	250.	Tail rotor drive system weight factor.
k_{ADS}	2649	250.	Auxiliary drive system weight factor.
k_{ADSZ}	2650	1.	Auxiliary drive system weight factor (number of gears in system).
k_{FS}	2651	.11	Fuel system weight factor.
k_{PEI}	2652	.17	Primary engine installation weight factor.
k_{AEI}	2653	.17	Auxiliary engine installation weight factor.
K_1	2654	1.	Main rotor controls weight factor.
K_2	2655	1.	Main rotor system controls weight multiplicative factor.
K_3	2656	1.	Fixed wing controls weight multiplicative factor.
K_4	2657	1.	Auxiliary rotor controls weight multiplicative factor.
K_5	2658	1.	Auxiliary rotor system controls weight multiplicative factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
K_6	2659	1.	Body weight multiplicative factor.
K_7	2660	1.	Landing gear weight multiplicative factor.
K_8	2661	1.	Wing weight multiplicative factor.
K_9	2662	1.	Horizontal tail weight multiplicative factor.
K_{10}	2663	1.	Primary nacelle weight multiplicative factor.
K_{11}	2664	1.	Auxiliary nacelle weight multiplicative factor.
K_{12}	2665	1.	Primary rotor blade weight multiplicative factor.
K_{13}	2666	1.	Primary rotor kit weight multiplicative factor.
K_{14}	2667	1.	Tail rotor weight multiplicative factor.
K_{15}	2668	1.	Auxiliary rotor weight multiplicative factor.
K_{16}	2669	1.	Primary drive system weight multiplicative factor.
K_{17}	2670	1.	Auxiliary drive system weight multiplicative factor.
K_{18}	2671	1.	Primary engine weight multiplicative factor.
K_{19}	2672	1.	Auxiliary engine weight multiplicative factor.
K_{20}	2673	1.	Tail rotor drive system weight multiplicative factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
		TAXI INFORMATION	
ATMIND	0401	.0	Standard atmosphere.
t_T	0411	.0333	Taxi for 2 minutes.
ΔT_{IN} (°F)	0421	.0	Increment in ambient temperature for primary engine sizing at takeoff conditions.
K_{FI}	0431	1.0	Auxiliary engine fuel flow multiplicative factor.

TAKEOFF, HOVER, AND LANDING INFORMATION

$N_{II}/N_{II}MAX$ (PRIM ENG)	0441	1.105	Operating point for engine power turbine during taxi

$$\frac{N_{II}}{N_{II_{MAX}}} = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II}}{N_{II}^*}\right)}$$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
TOLIND	0461 0462	1.0 1.0	Specify required T/W for hover out-of-ground of effect.
ATMIND	0481 0482	.0 .0	Standard atmosphere.
ΔT_{IN}(°F)	0501 0502	.0 .0	Increment in ambient temperature for primary engine sizing at takeoff conditions.
$V_{R/C}$ (FPM)	0511 0512	.0 .0	Vertical rate of climb.
T/W	0521 0522	1.06 1.06	Configuration thrust/weight ratio (hover).
ΔT_M(HR)	0531 0532	.02 .02	Step size for hover.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$N_{II}/N_{II}MAX$ (PRIM MAX)	0541 0542		Operating point for engine power turbine during takeoff, hover or landing $\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{TOHL} = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II_{MAX}}}{N_{II}}\right)}$
t_H	0551	0.1	Hover for 16 minutes.
	0552	0.2	Hover for 12 minutes.
CLIMB INFORMATION			
CLMIND	0571 0572	1.0 1.0	Climb at maximum rate of climb limited by NRP available.
ATMIND	0591 0592	.0 .0	Standard atmosphere.
C_L	0601 0602	0.3 0.4	Wing operating C_L in climb.
ΔT_{IN}(°F)	0611 0612	.0 .0	Incremental temperature above standard, in degrees.
Δh (FT)	0621 0622	500. 500.	Step size for climb.
POWIND	0631 0632	2. 2.	Normal engine rating.
h MAX	0641 0642	5000. 3000.	Maximum altitude during climb.
N_{II}/N_{II} MAX (PRIM ENG)	0651 0652	1.105 1.105	Specifies operating point for engine power turbine at design climb conditions.
$\Delta Fe_{CL}(FT^2)$	0661 0662	6. 6.	Increment in equivalent flat plate area parasite drag (climb performance segment).

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$N_{II}/N_{II}MAX$ (AUX ENG)	0671 0672	1.105 1.105	Specifies operating point for engine power turbine.
$N_{PSD_{CL}}$	0681 0682	1.0 1.0	One primary engine shut down during climb.
T_{AUX}/T_{TOT}	0691 0692	0 0	All propulsive thrust provided by main rotor
$N_{PSDi_{CL}}$	0701 0702	1.0 1.0	Auxiliary independent engine shut down during climb.
CRUISE INFORMATION			
CRSIND	0721	2.0	Cruise at specified TAS
	0722 0723	4.0 4.0	Cruise at 99 percent best range speed.
V_{IN}	0731	170.	True airspeed for cruise during cruise segment with CRSIND=2 (Kt)
ATMIND	0741 0742 0743	.0 .0 .0	Standard Atmosphere.
$C_{L_{WING}}$	0751 0752 0753	0.5 0.5 0.5	Wing operating C_L in cruise.
ΔT_{IN}(°F)	0761 0762 0763	.0 .0 .0	Incremental temperature above standard, in degrees.
ΔR(NM)	0771 0772 0773	15. 15. 15.	Step size for cruise (nautical miles).
POWIND	0781 0782	2. 2.	Normal engine rating.
R_{MAX}	0791 0792 0793	60 150 300	Values of range at end of each cruise.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$N_{II}/N_{II}MAX$	0801 0802 0803	1.105 1.105 1.105	Operating point of primary engine power tubine during cruise.

$$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{PRI\;CR} = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II_{MAX}}}{N_{II}^{*}}\right)_{PRI\;CR}}$$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$\Delta Fe_{CR}(FT^2)$	0811 0812 0813	.0 .0 .0	Increment in equivalent flat plate area parasite (cruise performance segment).
$N_{II}/N_{II}MAX$ (AUX ENG)	0821 0822 0823	1.105 1.105 1.105	Operating point for auxiliary engine power turbine cruise.

$$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{AUX\;CR} = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II_{MAX}}}{N_{II}^{*}}\right)_{AUX}}$$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$N_{PSD\;CR}$	0831 0832 0833	.0 .0 .0	Number of primary engines shut down during cruise.
T_{AUX}/T_{TOT}	0841 0842 0843	0.55 0.60 0.70	Propeller/main rotor propulsive thrust split during cruise segments.
$N_{PSD\;i\;CR}$	0851 0852 0853	.0 .0 .0	Number of auxiliary independent engines shut down during cruise.
LOITER INFORMATION STGIND=6			
ATMIND	1031 1032	.0 .0	Standard atmosphere.
C_{L_W}	1041 1042	0.4 0.4	Wing operating C_L in loiter.
$\Delta T_{IN}(°F)$	1051 1052	.0 .0	Incremental temperature above standard, in degrees.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
TRANSFER ALTITUDE SHEET			
ΔW_{PL}	1161	-1000.	Unload 1000 of payload after 12 minutes of hovering.
t_{PW} (HR)	1171	.01	Incremental time for change of payload weight.
h_{FINAL} (ft)	1181	1000.	Final altitude for transfer altitude segment (SGT IND=9).
WGTIND	1191	1.	No restriction on aircraft weight (will only apply when running performance).
PRIMARY ENGINE DATA			
WDTIND	1201	0.	No fuel flow cutoff.
N1IND	1202	0.	No gas generator RPM limit.
N1θIND	1203	0.	No referred gas generator RPM limit.
N2IND	1204	2.	Power turbine cutoff Non optimum N_{II} variation.
QIND	1205	0.	No torque limit imposed.
RNOIND	1206	0.	No Reynolds Number correction.
$N_{II}MAX/N_{II}^*$	1223	.905	Power turbine speed limit ratio of maximum power turbine speed to power turbine speed at maximum static power, sea level, Standard.
PRIMARY ENGINE CYCLE INFORMATION			
CYCLE NO.	1301	1.761	Engine Cycle Number.
k_3	1302	0.159	Primary engine weights multiplicative factor.
k_4	1303	0.	Primary engine weights additional factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ΔT_L(HR)	1061 1062	.05 .05	Step size for loiter.
$N_{II}/N_{II}MAX$ (PRIM ENG)	1071 1072	1.105 1.105	Operating point for primary engine power turbine during loiter.

$$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{LOITER} = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II_{MAX}}}{N_{II}^*}\right)} = 1.105$$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
t_L	1081	0.5	Loiter for 30 minutes.
	1082	0.25	Loiter for 15 minutes for reserve fuel purposes.
$N_{II}/N_{II}MAX$ (AUX ENG)	1091 1092	1.105 1.105	Operating point for auxiliary power turbine during loiter.

$$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{\substack{AUX\\LOITER}} = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II_{MAX}}}{N_{II}^*}\right)_{AUX}} = 1.105$$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
N_{PSD} LOITER	1101 1102	.0 .0	Number of primary engines shut down during loiter.
T_{AUX}/T_{TOT}	1111 1112	0.35 0.35	Propeller/main rotor propulsive thrust split in loiter.
$N_{PSD\ i}$ LOITER	1121 1122	.0 .0	Number of auxiliary independent engines shut down during loiter.
ΔFe_L	1131 1132	.0 .0	Increment in equivalent flat plate area parasite drag (loiter performance segment).

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ξ_4	1304	.032	Primary engine dimmensional factor.
T_{GI}(°R)	1305	950.	Turbine inlet temperature ground idle power setting in degrees Rankine.
T_{FI}(°R)	1306	1100.	Turbine inlet temperature, flight idle power setting, in degrees Rankine.
T_{NP}(°R)	1307	1856.	Turbine inlet temperature normal power setting. When this power setting is desired the input temperature is referred for the given altitude. The referred temperature, T/Θ, is used in the table look-up for referred power fuel flow, gas generator RPM limit, and power turbine speed.
T_{MIL}(°R)	1308	2000.	Turbine inlet temperature, military power setting. When this power setting is desired the input temperature is referred for the given altitude. The referred temperature, T/Θ, is used in the beforementioned table look-ups.
T_{MAX}(°R)	1309	2000.	Turbine inlet temperature, maximum power setting. When this power setting is desired the input temperature is referred for the given altitude. The referred temperature, T/Θ, is used in the beforementioned table look-up.
No. of T/θ	1310	8.	Number of referred temperatures in locations 1311-1318.
Values of T/θ	1311	950.	Values of referred temperature for the referred thrust or horsepower tables.
	1312	1200.	
	1313	1400.	
	1314	1600.	
	1315	1800.	
	1316	2000.	
	1317	2200.	
	1318	2600.	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
No. of M	1319	5.	Number of Mach. Numbers in location 1320-1325.
Values of M	1320	0.	Values of Mach. Number for the referred thrust or horse-power table.
	1321	.2	
	1322	.4	
	1323	.6	
	1324	.8	
Referred thrust or horsepower table.			
	1326	.025	Values of referred thrust or horsepower corresponding to T/θ location 1311 and mach numbers found in locations 1320-1324.
	1327	.0257	
	1328	.0278	
	1329	.0313	
	1330	.0362	
	1332	.163	Values of referred thrust or horsepower corresponding to T/θ location 1312 and mach numbers found in locations 1320-1324.
	1333	.1676	
	1334	.1813	
	1335	.2041	
	1336	.236	
	1338	.535	Values of referred thrust or horsepower corresponding to T/θ location 1313 and mach numbers found in locations 1320-1324.
	1339	.3444	
	1340	.3725	
	1341	.4194	
	1342	.4851	
	1344	.544	Values of referred thrust or horsepower corresponding to T/θ location 1314 and mach number locations 1320-1324.
	1345	.5592	
	1346	.6049	
	1347	.6811	
	1348	.7877	
	1350	.77	Values of referred thrust or horsepower corresponding to T/θ location 1315 and mach number locations 1320-1324.
	1351	.7916	
	1352	.8562	
	1353	.9640	
	1354	1.115	
	1356	1.0	Values of referred thrust or horsepower corresponding to T/θ location 1316 and mach number locations 1320-1324.
	1357	1.028	
	1358	1.112	
	1359	1.252	
	1360	1.448	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
	1362	1.2	Values of referred thrust or horsepower corresponding to T/θ location 1317 and mach number locations 1320-1324.
	1363	1.2336	
	1364	1.3344	
	1365	1.5024	
	1366	1.7376	
	1368	1.55	Values of referred thrust or horsepower corresponding to T/θ location 1318 and mach number locations 1320-1324.
	1369	1.5934	
	1370	1.7236	
	1371	1.9406	
	1372	1.2444	
No of T/θ	1374	8.	Number of referred temperatures in locations 1375-1382.
Values of T/θ	1375	950.	Values of referred temperature for the referred fuel flow table.
	1376	1200.	
	1377	1400.	
	1378	1600.	
	1379	1800.	
	1380	2000.	
	1381	2200.	
	1382	2600.	
No. of M	1383	5.	Number of mach numbers in locations 1384-1389.
Values of M	1384	0.	Values of mach numbers for the referred fuel flow table.
	1385	.2	
	1386	.4	
	1387	.6	
	1388	.8	
Referred Fuel Flow Table			
	1390	.065	Values of referred fuel flow corresponding to the T/θ location 1375 and mach numbers found in locations 1384-1388.
	1391	.0651	
	1392	0653	
	1393	.067	
	1394	.071	
	1396	.115	Values of referred fuel flow corresponding to T/θ location 1376 and mach numbers found in locations 1384-1388.
	1397	.116	
	1398	.118	
	1399	.128	
	1400	.14	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
	1402	.18	Value of referred fuel flow corresponding to T/θ location 1377 and mach numbers found in locations 1384-1388.
	1403	.181	
	1404	.19	
	1405	.208	
	1406	.227	
	1408	.26	Values of referred fuel flow corresponding to T/θ location 1378 and mach number found in locations 1384-1388.
	1409	.261	
	1410	.273	
	1411	.295	
	1412	.325	
	1414	.342	Values of referred fuel flow corresponding to T/θ location 1379 and mach numbers found in locations 1384-1388.
	1415	.347	
	1416	.362	
	1417	.389	
	1418	.425	
	1420	.425	Values of referred fuel flow corresponding to T/θ location 1380 and mach numbe bound in locations 1384-1388.
	1421	.435	
	1422	.451	
	1423	.486	
	1424	.517	
	1426	.5	Values of referred fuel flow corresponding to T/θ location 1381 and mach numbers found in locations 1384-1388
	1427	.511	
	1428	.53	
	1429	.56	
	1430	.61	
	1432	.626	Values of referred fuel flow corresponding to T/θ locatio 1382 and mach numbers found locations 1384-1388.
	1433	.631	
	1434	.66	
	1435	.718	
	1436	.78	
No. of T/θ	1438	3.	Number of referred temperatu found in locations 1439-1446
Values of T/θ	1439	950.	Values of referred temperatu for the referred gas generat RPM.
	1440	1600.	
	1441	2600.	
No. of M	1447	3.	Number of mach numbers in lo tion 144-1453.
Values of M	1448	0.	Values of mach number for t referred gas generator RPM.
	1449	.4	
	1450	.8	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Referred Gas Generator RPM table	1454	.26	Values of referred gas generator RPM limit corresponding to T/θ location 1439 and mach numbers found in locations 1448-1453.
	1455	.271	
	1456	.29	
	1460	.82	Values of referred gas generator RPM limit corresponding to T/θ location 1440 and mach numbers in locations 1448-1453.
	1461	.84	
	1462	.9	
	1466	1.09	Values of refereed gas generator RPM limit corre- 1441 and mach numbers found in locations 1448-1453.
	1467	1.118	
No. of T/θ	1502	8.	Number of referred temperatures in locations 1510.
Values of T/θ	1503	950.	Values of referred temperature for the referred power turbine speed limit ratio.
	1504	1200.	
	1505	1400.	
	1506	1600	
	1507	1800.	
	1508	2000.	
	1509	2200.	
	1510	2600.	
No. of M	1511	5.	Number of mach numbers in locations 1512-1517.
Values of M	1512	0.	Values of mach number for the referred power turbine speed limit ratio.
	1513	.2	
	1514	.4	
Referred Power Turbine Limit Table			
	1518	.26	Values of referred power turbine speed limit corresponding to T/θ location 1503 and mach numbers found in locations 1512-1517.
	1519	.256	
	1520	.271	
	1521	.28	
	1522	.29	
	1524	.52	Values of referred power turbine speed limit corresponding to location 1504 and mach numbers found in locations 1512-1517.
	1525	.527	
	1526	.54	
	1527	.56	
	1528	.59	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
	1530	.68	Values of referred tur-
	1531	.69	bine speed limit corre-
	1532	.705	sponding to T/θ location
	1533	.73	1505 and mach numbers found
	1534	.76	in locations 1512-1517.
	1536	.82	Values of referred power tur-
	1537	.824	bine speed limit corresponding
	1538	.84	to T/θ location 1506 and mach
	1539	.868	numbers found in locations
	1540	.9	1512-1517.
	1542	.92	Values of referred power tur-
	1543	.93	bine speed limit corresponding
	1544	.95	to T/θ location 1507 and mach
	1545	.98	numbers found in locations
	1546	1.02	1512-1517.
	1548	1.0	Values of referred power tur-
	1549	1.002	bine speed limit correspondin
	1550	1.02	to T/θ location 1508 and mach
	1551	1.05	numbers found in locations
	1552	1.09	1512-1517.
	1554	1.052	Values of referred power tur-
	1555	1.055	bine speed limit correspondin
	1556	1.07	to T/θ location 1509 and mach
	1557	1.1	numbers found in locations
	1558	1.131	1512-1517.
	1560	1.09	Values of referred power tur-
	1561	1.1	bine speed limit correspondin
	1562	1.118	to T/θ location 1510 and
	1563	1.135	mach numbers found in locatio
	1564	1.165	1512-1517.

Since this example utilized an auxiliary engine, the auxiliary engine cycle input locations were created by placing a 66666 card in front and behind a standard engine cycle. The 66666 cards added an additional 1000 on the standard engine cycle input locations. This is shown in the output as locations 2201 to 1564. The auxiliary engine inputs are identical to the primary engine inputs for this example. The auxiliary engine cycle input locations are not listed in order to avoid redundancy.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
SHORT FORM AERO (MAIN) ROTOR CYCLE INFORMATION			
Rotor Cycle No.	1601	3.	Input rotor cycle number.
$\theta_{TWIST\ REF}$	1602	-9.	
$C_{D_{B_O}}$	1603	.00995	Baseline rotor hover profile drag coefficient.
K_H	1604	-.028	Rotor blade hover profile drag parameter.
K_{H_2}	1605	.262	Rotor blade hover compressibility drag parameter.
K_{H_3}	1606	.276	Rotor blade hover compressibility drag parameter.
$K_{H\ 4}$	1607	2.54	Rotor blade hover drag divergence mach number parameter.
$M_{D_{B_O}}$	1608	.865	Baseline rotor hover compressibility drag rise, left=0, mach number.
C_{D_B}	1609	.0105	Baseline rotor cruise profile drag coefficient.
K_{C_1}	1610	2.82	Rotor retreating blade stall profile drag parameter.
K_{C_2}	1611	.09	Rotor retreating blade stall profile drag parameter.
K_{C_3}	1612	1.17	Rotor advancing tip mach number compressibility
K_{C_4}	1613	.00124	drag parameter.
K_{C_5}	1614	.758	
M_{D_O}	1615	.743	Baseline rotor advancing tip compressiblity drag rise mach number.
No. of C_T	1616	10.	Number of C_T's input in locations 1617-1626.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Values of C_T	1617	0.	Values of propeller thrust coefficient.
	1618	.004	
	1619	.007	
	1620	.009	
	1621	.01	
	1622	.011	
	1623	.0115	
	1624	.012	
	1625	.0155	
	1626	.022	
Values of K_{HOV_A}	1627	1.018	Values of rotor hover induced power factor.
	1628	1.085	
	1629	1.154	
	1630	1.233	
	1631	1.279	
	1632	1.314	
	1633	1.327	
	1634	1.337	
	1635	1.364	
	1636	1.397	

SAMPLE CASE NO 1. RUN 2.

OPTIND	0001	0	Size for weights only, no performance mission.

HESCOMP
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-91

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+0001
VAL2 VALUE CORRESPONDING TO LOC.+0002
ETC.

NOTE : IN USING AUXILIARY ENGINES : AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
1201	5	.0	.0	.0	2. [illegible]	.0
1206	1	.0				
1223	1	.90500				
1301	5	1.761[illegible]	.15900	.0	.32000E-01	950.00
1306	5	1190.0	1856.0	2000.0	2[illegible]	8.0000
1311	5	870.0	1200.0	1400.0	16[illegible]	1800.0
1316	5	2330.0	2200.0	2600.0	5.00[illegible]	.0
1321	4	.20000	.4[illegible]00	.60[illegible]	.6[illegible]	
1326	5	.0	.0	.0	.0	.0
1332	5	.163[illegible]	.16760	.18130	.20410	.23600
1338	5	.335[illegible]	.34440	.37250	.41940	.48510
1344	5	.54400	.55920	.60490	.68110	.7877[illegible]
1350	5	.77050	.79160	.8562[illegible]	.964[illegible]	1.115
1356	5	1.[illegible]	1.[illegible]280	1.1120	1.2520	1.44[illegible]
1362	5	1.2[illegible]	1.2336	1.3344	1.5[illegible]24	1.7376
1368	5	1.55[illegible]	1.5934	1.7236	1.94[illegible]	2.2444
1374	5	[illegible]	870.00	1200.0	1400.0	16[illegible]
1379	5	1800.0	2000.0	22[illegible]	26[illegible]	5.[illegible]
1384	5	.0	.2[illegible]	.40[illegible]	.60000	.80000
1390	5	.65[illegible]E-01	.65100E-01	.653[illegible]E-01	.67[illegible]E-01	.71[illegible]E-01
1396	5	.115[illegible]	.11600	.118[illegible]	.128[illegible]	.14[illegible]
1402	5	.1[illegible]	.16100	.1[illegible]	.2[illegible]	.227[illegible]
1408	5	.260[illegible]	.26100	.272[illegible]	.295[illegible]	.325[illegible]
1414	5	.342[illegible]	.34700	.362[illegible]	.38900	.425[illegible]
1420	5	.42500	.43500	.45100	.4[illegible]	.517[illegible]
1426	5	.5[illegible]	.51100	.53[illegible]	.5[illegible]	.61[illegible]
1432	5	.626[illegible]	.631[illegible]	.66[illegible]	.718[illegible]	.7[illegible]
1438	4	3.0000	870.00	1650.[illegible]	26.[illegible]	
1447	4	3.[illegible]	.0	.4[illegible]	.8[illegible]	
1454	3	.26000	.27100	.29000		
1460	3	.92[illegible]	.94[illegible]	.9[illegible]		
1466	3	1.[illegible]	1.1180	1.16[illegible]		
1502	5	8.[illegible]	87[illegible].00	1200.0	14[illegible]	1600.0
1507	5	1[illegible]	2[illegible]	22[illegible]	26[illegible]	5.0000
1512	5	.0	.20000	.46000	.6[illegible]	.80000
1518	5	.26[illegible]	.265[illegible]	.271[illegible]	.2[illegible]	.29000
1524	5	.52[illegible]	.52700	.54[illegible]	.5[illegible]	.59000
1530	5	.680[illegible]	.69000	.70[illegible]	.73[illegible]	.76000

1576	5	.82000	.82400	.83800	.96600	.[illegible]
1542	5	.92[illegible]	.93700	.95[illegible]	.96[illegible]	1.[illegible]
1548	5	1.0[illegible]	1.0020	1.0200	1.[illegible]	1.[illegible]
1554	5	1.0520	1.0550	1.07[illegible]	1.1[illegible]	1.131[illegible]
156[illegible]	5	1.[illegible]	1.1[illegible]	1.115	1.135	1.165
22 1	5	.0	.0	.0	2.0000	.0
22 [illegible]	1	.[illegible]				
2223	2	.9.5[illegible]	.[illegible]			
23 1	5	1.7613	.15900	.0	.32[illegible]E-01	95.[illegible]
23 6	5	1100.0	1856.[illegible]	2[illegible]00.	2[illegible]	[illegible]
2311	5	876.66	1200.0	1400.0	1660.0	1[illegible]00.0
2316	5	2[illegible]00.0	22[illegible].0	26[illegible]	5[illegible]	.
2321	4	.24[illegible]	.4[illegible]000	.6[illegible]	.6[illegible]	
2326	5	.0	.0	.0	.	.
2332	5	.163[illegible]	.16760	.1915[illegible]	.2[illegible]41	.236
2338	5	.32560	.34440	.37250	.41940	.45510
2344	5	.544[illegible]	.55920	.6[illegible]89	.6[illegible]1	.7877
2350	5	.77[illegible]	.77160	.856[illegible]	[illegible]	1.115
2356	5	1.00[illegible]	1.0280	1.3123	[illegible]52	1.446
2362	5	1.20[illegible]	1.2236	1.3344	[illegible]24	1.7276
2368	5	1.5500	1.5534	1.7230	[illegible]86	2.2444
2374	5	8[illegible]	87[illegible].00	1200.0	14[illegible]	16[illegible]
2378	5	13[illegible]	2[illegible]	220[illegible].	26[illegible]	5[illegible]
2384	5	.0	.2[illegible]	.40000	.[illegible]	.[illegible]
2390	5	.65[illegible]E-1	.651[illegible]E-01	.657[illegible]E-01	.67[illegible]E-01	.71[illegible]E-
2396	5	.115[illegible]	.11600	.11800	.12[illegible]00	.14000
24 2	5	.16[illegible]	.18100	.190[illegible]	.2[illegible]	.24[illegible]
24 8	5	.2[illegible]	.26100	.273[illegible]	.2[illegible]	.325[illegible]
2414	5	.34200	.34700	.362[illegible]	.380[illegible]	.425
2420	5	.42500	.435[illegible]	.451	.4[illegible]6	.517[illegible]
2426	5	.5[illegible]	.51100	.53000	.56000	.61000
2432	5	.626[illegible]	.63100	.66[illegible]	.71[illegible]	.76[illegible]
2436	4	3.[illegible]	17[illegible].00	1600.	26[illegible]	
2447	4	3.[illegible]	.0	.40000	.6[illegible]0	
2454	3	.26300	.27100	.29[illegible]		
245[illegible]	3	.82[illegible]	.84[illegible]00	.9[illegible]		
2476	3	1.[illegible]	1.1160	1.165[illegible]		
25 2	5	8[illegible]	87[illegible].00	1200.[illegible]	14[illegible]	160[illegible]
25 7	5	18[illegible].0	2[illegible].0	2200.[illegible]	26[illegible]	5[illegible]
2512	5	.0[illegible]	.24600	.4[illegible]	.6[illegible]	.[illegible]
2518	5	.24[illegible]	.24500	.271	.2[illegible]00	.2[illegible]
2524	5	.52[illegible]	.52700	.54[illegible]	.56[illegible]	.5[illegible]
253[illegible]	5	.6[illegible]	.6[illegible]00	.715[illegible]	.73[illegible]	.76
2536	5	.82[illegible]	.824[illegible]	.84800	.86800	.9
2542	5	.92500	.93000	.95000	.9[illegible]	1.[illegible]2
2548	5	1.0[illegible]	1.[illegible]2[illegible]	1.02[illegible]	1.[illegible]	1.0[illegible]
2554	5	1.[illegible]	1.[illegible]65	1.07[illegible]	1.1[illegible]	1.131
255[illegible]	5	1.0[illegible]	1.1[illegible]00	1.118	1.135	1.165
16 1	2	3.[illegible]	-.5.[illegible]			
16[illegible]	5	.74813E-02	-.26[illegible]E-01	.26200	.[illegible]76	2.45
16 8	1	.865				
16 9	5	.79[illegible]E-02	2.[illegible]20	.9[illegible]0[illegible]E-01	1.17[illegible]	.124[illegible]
1614	2	.78[illegible]	.74730			
1616	5	1.[illegible]	.[illegible]	.4[illegible]E-2	.7[illegible]E-01	.[illegible]E-
16[illegible]1	5	.10600E-01	.11600E-01	.11500E-01	.12[illegible]E-01	.1[illegible]E-
1626	5	.22[illegible]E-1	1.[illegible]18	1.0[illegible]	1.154	1.23[illegible]
1631	5	1.27[illegible]	1.3140	1.327	1.337	1.364
1636	1	1.3971				
[illegible]	5	1.[illegible]	1.[illegible]3	2.[illegible]	.[illegible]	1.[illegible]
[illegible]	5	4.600[illegible]	4.[illegible]00	1.5000	1.[illegible]	5.[illegible]

11	5	1.00[illegible]	2.[illegible]00	.1	1.[illegible]	1.[illegible]
16	4	2.[illegible]	2.[illegible]00	2.0000	.[illegible]	
22	5	2.0000	25[illegible]	.0	.0	.[illegible]
27	5	.0	.33[illegible]0	223.[illegible]	22.[illegible]	3.5[illegible]
32	5	1.[illegible]	.0	1.0550	1.0000	2.0000
37	5	4.[illegible]	3.[illegible]00	4.0000	5.[illegible]	2.[illegible]
42	5	[illegible]	6.[illegible]00	3.[illegible]	4.[illegible]	6.[illegible]
47	1	100.[illegible]				
103	1	.50000				
105	5	.2[illegible]	.12[illegible]00	.0	.50000	1.0000
110	5	.2[illegible]	.[illegible]	4.[illegible]	1.15[illegible]	.12[illegible]
115	2	.162[illegible]E-01	.5[illegible]00			
120	5	.0	.0	7.0[illegible]	[illegible]	1.5[illegible]
125	5	1.[illegible]	12.[illegible]00	.[illegible]	.55[illegible]	5.[illegible]
130	2	.3[illegible]	1.1000			
136	5	.45[illegible]	.15[illegible]0	.80[illegible]	.8[illegible]	.5[illegible]
141	5	1[illegible]	.35[illegible]E-01	2.[illegible]	.78[illegible]E-01	.1[illegible]
146	5	.353[illegible]E-01	2.[illegible]00	.78900E-01	.[illegible]	.
151	1	.1[illegible]				
152	5	.40[illegible]	.20000	.50000	.47056	3.[illegible]
171	3	3.[illegible]	1.0000	11.[illegible]		
176	5	4.[illegible]	-9.[illegible]00	.25[illegible]	.75[illegible]E-01	.1[illegible]
181	5	725.[illegible]	.12[illegible]00	1.06[illegible]	1[illegible]	5[illegible]
186	5	43.2	.11[illegible]	1.75[illegible]	1.25	1.[illegible]
191	3	1.5[illegible]	.[illegible]	.85000		
2[illegible]	5	5.[illegible]	-4.[illegible]00	.37[illegible]	.7[illegible]E-01	[illegible]
2[illegible]	5	.17[illegible]	.3[illegible]00	.75[illegible]	1.[illegible]	.72[illegible]
213	3	1.[illegible]	1.0000	1.05[illegible]		
216	1	.0				
217	1	1.761[illegible]				
2[illegible]	3	2.[illegible]	2.[illegible]00	1.[illegible]		
223	5	.97[illegible]	10[illegible].00	1.00[illegible]	1.[illegible]	4.[illegible]
228	5	1.0600	50.300	1.105[illegible]	.0	.55[illegible]
233	5	.[illegible]	2.[illegible]	3.[illegible]	17.[illegible]	43.[illegible]
236	4	1.12[illegible]	.75000	.30000	.0	
242	1	1.761[illegible]				
245	1	1.[illegible]				
246	2	2.0000	1.1050			
248	5	1.[illegible]	9[illegible].00	1[illegible]	.7[illegible]E-01	.6[illegible]
25[illegible]	1	.0				
254	2	.820[illegible]	.8[illegible]00			
257	2	14.[illegible]	3.[illegible]00			
261	1	4.[illegible]				
262	4	.0	.2[illegible]00	.4[illegible]	.0	
272	4	.55[illegible]	.6[illegible]	.8[illegible]	.75[illegible]	
312	4	1130.0	.55500	.7500[illegible]	1.0000	
3[illegible]	1	.0				
327	1	1.[illegible]				
328	2	.14[illegible]E+07	[illegible]			
33[illegible]	1	7.[illegible]				
331	5	.0	.20000	.4[illegible]	.0	.0
336	2	1.[illegible]	1.4[illegible]00			
3[illegible]	5	.6[illegible]E-02	.62[illegible]E-02	.77[illegible]E-0[illegible]	.[illegible]E-02	.[illegible]
344	2	.12[illegible]E-01	.2[illegible]E-01			
2[illegible]2	3	2200.[illegible]	45[illegible]	2[illegible]		
26[illegible]	3	100.00	.[illegible]	.		
26[illegible]	5	.[illegible]	.0	.0	.[illegible]	.0
2613	5	25.[illegible]	25.000	25.00	.	.
2619	4	3.[illegible]	.1[illegible]	25.[illegible]	.	
2622	5	125.[illegible]	2.[illegible]	.400[illegible]E-01	.[illegible]	.

2627	5	1.0000	.0	2.0600	2.0000	24.1[illegible]
2632	5	1.0000	.75000	1.6050	.75000	.0
2637	5	44.000	2.2000	61.000	.25600	1.1500
2642	5	14.200	14.200	1.0000	1.0000	250.00
2647	5	3.0000	250.00	250.00	1.0000	.110[illegible]
2652	2	.17000	.17000			
2654	5	1.0000	1.0000	1.0000	1.0000	1.0000
2659	5	1.0000	1.0000	1.0000	1.0000	1.0000
2664	5	1.0000	1.0000	1.0000	1.0000	1.0000
2669	5	1.0000	1.0000	1.0000	1.0000	1.0000
347	5	3.0000	3.0000	.0	.5[illegible]	1.0[illegible]
354	3	.0	.50000	1.0000		
361	3	1.0000	1.0000	1.0000		
368	3	1.0000	1.0000	1.0000		
375	3	1.0000	1.0000	1.0000		
401	1	.0				
411	1	.33300E-01				
421	1	.0				
431	1	1.0000				
441	1	1.1050				
461	2	1.0000	1.0000			
481	2	.0	.0			
501	2	.0	.0			
511	2	.0	.0			
521	2	1.[illegible]	1.0000			
531	2	.2[illegible]E-01	.2[illegible]E-01			
541	2	1.1050	1.1350			
551	2	.1[illegible]	.2[illegible]			
571	2	1.0000	1.0000			
591	2	.0	.0			
601	2	.[illegible]	.4[illegible]			
611	2	.0	.0			
621	2	500.00	500.00			
631	2	2.[illegible]	2.[illegible]			
641	2	5000.0	3000.0			
651	2	1.105[illegible]	1.1050			
661	2	6.[illegible]	6.[illegible]			
671	2	1.1050	1.1050			
681	2	1.0000	1.0000			
691	2	.[illegible]	.0			
701	2	1.0000	1.0000			
721	3	2.[illegible]	4.[illegible]	4.[illegible]		
731	1	17.[illegible]				
741	3	.[illegible]	.0	.0		
751	3	.50000	.50000	.50000		
761	3	.0	.0	.0		
771	3	15.000	15.000	15.000		
781	3	2.[illegible]	2.[illegible]	2.[illegible]		
791	3	[illegible]	15[illegible]	3[illegible]		
801	3	1.105[illegible]	1.1[illegible]50	1.1[illegible]5		
811	3	.0	.0	.0		
821	3	1.1070	1.1[illegible]	1.1[illegible]		
831	3	.[illegible]	.0	.0		
841	3	.55[illegible]	.6[illegible]00	.7[illegible]		
851	3	.[illegible]	.[illegible]	.[illegible]		
1031	2	.0	.0			
1041	2	.4[illegible]	.4[illegible]			
1051	2	.0	.0			
1061	2	.[illegible]E-01	.5[illegible]E-01			
1071	2	1.10[illegible]	1.1[illegible]50			

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1081        2        .50000         .25000
1091        2        1.1050         1.1050
1101        2        .0             .0
1111        1        .35000
1121        2        .0             .0
1131        2        .0             .0
1161        1        -1000.0
1171        1        .10000E-01
1181        1        1000.0
1191        1        1.0000
WG = 0.250000E+05  WFA = 0.0            WFR = 0.0
WG = 0.250000E+05  WFA = 0.75663 E+04   WFR = 0.512263E+04
WG = 0.215093E+05  WFA = 0.567573E+04   WFR = 0.448605E+04
WG = 0.181972E+05  WFA = 0.4 3652E+04   WFR = 0.347657E+04
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   R-81

SINGLE ROTOR COMPOUND HELICOPTER AUX. INDEPENDENT T/SHAFT CRUISE PROPULSION

S I Z E D A T A   THIS RUN CONVERGED IN 4 ITERATIONS

GROSS WEIGHT = 1762[illegible]. LB

FUSELAGE

LF	LENGTH(BODY+TAILBOOM)	[illegible].1 FT.
LC	LENGTH(CABIN)	12.0 FT.
LB	LENGTH(BODY)	27.[illegible] FT.
LTB	LENGTH(TAILBOOM)	22.6 FT.
XM	FWD. ROTOR LOCATION	15.1 FT.
WF	WIDTH	6.5 FT.
SF	WETTED AREA	7[illegible].2 SQ. FT.

WING

AR	ASPECT RATIO	4.51
SW	AREA	113.[illegible] SQ. FT.
BW	SPAN	[illegible] FT.
CBARW	MEAN CHORD	[illegible] FT.
LAMBDA C/4	QUARTER CHORD SWEEP	[illegible] DEG.
LAMBDA	TAPER RATIO	.[illegible]
(T/C)R	ROOT THICKNESS/CHORD	.[illegible]
(T/C)T	TIP THICKNESS/CHORD	0.12[illegible]
WG/SW	WING LOADING	1[illegible].7 LB/SQ. FT.
GRW	ROTOR/WING GAP	[illegible] FT.
CF/C	FLAP CHORD/MEAN CHORD RATIO	1.[illegible]

HOR. TAIL

ARHT	ASPECT RATIO	4.[illegible]
SHT	AREA	[illegible] SQ. FT.
BHT	SPAN	11.[illegible] FT.
CBARHT	MEAN CHORD	[illegible] FT.
LAMBDA H	TAPER RATIO	[illegible]
(T/C)HT	THICKNESS/CHORD	.12[illegible]
LTH	HOR. TAIL ARM	[illegible] FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.[illegible]
SVT	AREA	[illegible] SQ. FT.
BVT	SPAN	[illegible].7 FT.
CBARVT	MEAN CHORD	[illegible].7 FT.
LAMBDA VT	TAPER RATIO	.4[illegible]
ZTR	TAIL ROTOR(VERT.) LOCATION	4.5 FT.
ZBTAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	[illegible]

(T/C)VT	THICKNESS/CHORD	0.150

MAIN ROTOR PYLON

AR	ASPECT RATIO	0.500
SFP	WETTED AREA	39.1 SQ. FT.
FAFP	FRONTAL AREA	6.2 SQ. FT.
HP1	HEIGHT	3.0 FT.
CBARFP	MEAN CHORD	6.0 FT.
LAMBDA FP	TAPER RATIO	0.400
(T/C)R	ROOT THICKNESS/CHORD	0.400
(T/C)T	TIP THICKNESS/CHORD	0.200

PRIMARY ENGINE NACELLE

LN	LENGTH	5.8 FT.
DN	MEAN DIAMETER	2. FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	60.9 SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE

LNI	LENGTH	4.8 FT.
DNI	MEAN DIAMETER	1. FT.
SNI	WETTED AREA(TOTAL FOR ALL ENGINES)	19. SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE STRUT

SSTR	WETTED AREA(TOTAL)	0. SQ. FT.
BNS	SPAN	0.1 FT.
CNS	MEAN CHORD	2.8 FT.

PROPELLER(AUXILIARY PROPULSION)

DAR	DIAMETER	[illegible] FT.
AF	ACTIVITY FACTOR PER BLADE	140.0
SIGAR	SOLIDITY	0.171
NRA	NO. OF PROPELLERS	1.
NO. BLADES	NO. OF BLADES/PROP	3.
VTIP	TIP SPEED	900. FT./SEC

MAIN ROTOR

DMR	DIAMETER	45.2 FT.
SIGMR	SOLIDITY	0.12[illegible]
WG/A	DISC LOADING	11.0 LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.11[illegible]
NP	NO. OF ROTORS	1.
NO. BLADES	NO. OF BLADES/ROTOR	4.
THETA	BLADE TWIST	-8.[illegible] DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.250
VTIP	TIP SPEED	725. FT./SEC.

TAIL ROTOR

DTR	DIAMETER	1[illegible].5 FT.
SIGTR	SOLIDITY	0.237
(T/A)NET	NET DISC LOADING	17.6 LB./SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	.17[illegible]
NO. BLADES	NO. OF BLADES/ROTOR	5.
THETA	BLADE TWIST	-4.[illegible] DEG.

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                                   H E S C O M P
                HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    8-91


P R O P U L S I O N   D A T A
         PRIMARY PROPULSION CYCLE NO.     1.761
                 TURBOSHAFT ENGINE

                  2.  ENGINES

             PHP-P          MAX. STANDARD S.L. STATIC H.P.          4634.     H.P.

             ENGINE SIZED FOR TAKEOFF AT T/W =1.06
              95.  PERCENT MILITARY POWER SETTING.
             H = 4 0. FT. TEMPERATURE = 95.94 DEG.F.,
              .    ENGINES INOPERATIVE. AND    0.   FT/MIN VERTICAL RATE OF CLIMB.

         AUX. INDEPENDENT PROPULSION CYCLE NO.     1.761
                 TURBOSHAFT ENGINE

                  1.  ENGINES

             PHP-PI         MAX. STANDARD S.L. STATIC H.P.          1282.     H.P.

             ENGINE SIZED FOR CRUISE AT VC = 17 . KNOTS.
              NORMAL  POWER SETTING.
             HC =  3  . FT. TEMPERATURE =  91.F0 DEG.F.,
             AND   .    ENGINES INOPERATIVE.


                 MAIN AND TAIL ROTOR DRIVE SYSTEM RATING          3757.     H.P.


                 MAIN ROTOR DRIVE SYSTEM RATING          2 21.     H.P.

         XMSN SIZED AT 1  . PERCENT OF MAIN ROTOR HOVER POWER REQUIRED
         AT H = 4  . FT. TEMP = 95.94 DEG.F., 100.0 PERCENT HOVER RPM

                 TAIL ROTOR DRIVE SYSTEM RATING          477.     H.P.

         XMSN SIZED AT 1  . PERCENT OF TAIL ROTOR HOVER POWER REQUIRED
         AT H = 4   . FT. TEMP = 95.94 DEG.F., 10  PERCENT HOVER RPM

                 AUXILIARY INDEPENDENT PROPULSION DRIVE SYSTEM RATING              .     H.P.

         XMSN SIZED AT 1  . PERCENT OF AUX. PROPULSION CRUISE POWER REQUIRED AT VC =17   KT.
         HC =  3   . FT. TEMP= 91.F0 DEG.F.
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XCTR	BLADE CUTOUT/RADIUS RATIO	.3
G	MAIN/TAIL ROTOR GAP	1. FT.
VTIP	TIP SPEED	690. FT./SEC.

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                                  H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM     B-91


W E I G H T S   D A T A     IN LBS

        MLF           MANEUVER LOAD FACTOR                           3.500
        GLF           GUST LOAD FACTOR                               1.500
        ULF           ULTIMATE LOAD FACTOR                           5.250

    PROPULSION GROUP
             WPRG     TOTAL MAIN ROTOR GROUP                           1765.
        K12  WPRB         MAIN ROTOR BLADE (PER ROTOR)                      1026.
        K13  WPH          MAIN ROTOR HUB (PER ROTOR)                         512.
             WPF          BLADE FOLDING(PER ROTOR)                           231.
        K15  WAR      AUXILIARY PROPULSION ROTOR GROUP                  132.
             WDS      DRIVE SYSTEM                                     1666.
        K16  WPDS         MAIN ROTOR DRIVE SYSTEM                           1362.
        K20  WTRDS        TAIL ROTOR DRIVE SYSTEM                            119.
        K17  WADS         AUXILIARY PROPULSION DRIVE SYSTEM                  2[illegible]5.
        K18  WEP      PRIMARY ENGINES                                   737.
        K19  WEA      AUXILARY ENGINES                                  2[illegible]4.
             WPEI     PRIMARY ENGINE INSTALLATION                       125.
             WAEI     AUXILIARY ENGINE INSTALLATION                      35.
             WFS      FUEL SYSTEM                                       416.
       DELTA WP       PROPULSION GROUP WEIGHT INCREMENT                   0.
             WP   TOTAL PROPULSION GROUP WEIGHT                                          5103.

    STRUCTURES GROUP
        K8   WW       WING                                              234.
             WTG      TAIL GROUP                                        194.
        K9   WHT          HOR. TAIL                                           71.
        K14  WTR          TAIL ROTOR                                         123.
        K6   WB       FUSELAGE                                         1946.
        K7   WLG      LANDING GEAR                                      707.
             WNG          NOSE GEAR                                          141.
             WMG          MAIN GEAR                                          566.
             WTES     TOTAL ENGINE SECTION                              196.
             WPES         PRIMARY ENGINE SECTION                             145.
             WAES         AUXILIARY ENGINE SECTION                            51.
      DELTA WST       STRUCTURE WEIGHT INCREMENT                          0.
             WST  TOTAL STRUCTURE WEIGHT                                                 3277.

    FLIGHT CONTROLS GROUP
             WPFC     PRIMARY FLIGHT CONTROLS                           716.
             WCC          COCKPIT CONTROLS                                    61.
        K1   WRC          MAIN ROTOR CONTROLS                                357.
        K2   WSC          MAIN ROTOR SYSTEMS CONTROLS                        248.
        K3   WFW          FIXED WING CONTROLS                                  0.
             WTM          TILT MECHANISM                                       0.
             WSAS         SAS                                                3[illegible].
             WAFC     AUXILIARY FLIGHT CONTROLS                          55.
        K4   WPCA         AUX. PROPULSION ROTOR CONTROLS                      24.
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 WF   WSCA            AUX. PROPULSION ROTOR SYS. CONTROLS        31.
      WMC             MISCELLANEOUS CONTROLS                      0.
DELTA WFC         CONTROL WEIGHT INCREMENT                 190.
      WFC     TOTAL CONTROL WEIGHT                                       871.

WFE           WEIGHT OF FIXED EQUIPMENT                                 2210.

WE            WEIGHT EMPTY                                             11452.

WFUL          FIXED USEFUL LOAD                                          450.

OWE           OPERATING WEIGHT EMPTY                                   11902.

WPL           PAYLOAD                                                   2000.

WFIA          FUEL                                                      3781.

WG            GROSS WEIGHT                                             17683.


SAMPLE CASE NO. 1   RUN 1                                             PAGE   4

                                   H E S C O M P
             HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM     B-91


    R O T O R  D A T A

          ROTOR CYCLE NO.    3.0000

          MAIN ROTOR SOLIDITY SIZED BY MANUEVER CONDITIONS
          H =      3000.0 FT. , TEMP =      51.5 DEG. , V =      165.0 KT.
          100.0 PERCENT HOVER RPM
          ROTOR MANUEVER G'S =  1.350 , CT/SIGMA = 0.110

          TAIL ROTOR SIZED AT       1.000 TIMES THE SOLIDITY
          REQUIRED TO SATISFY HOVERING TURN REQUIREMENTS AT :
                         H                            =     4000.0 FT.
                         TEMP                         =     95.335 DEG..F.
                         CTG/CTNET                    =      1.243
                         YAW RATE                     =      0.750 RAD/SEC.
                         YAW ACCELERATION             =      0.300 RAD/SEC2
                         TAIL ROTOR POLAR
                         MOM. OF INERTIA(PER BLADE) =      4.122 SLUG/FT2
                         HELICOPTER YAW
                         MOM. OF INERTIA              =    36505.9 SLUG/FT2
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END  OF  SUCCESSFUL  CASE

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SAMPLE CASE NO. 1    RUN 1                                                          PAGE   6

                                          H E S C O M P
                   HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    8-91


A E R O D Y N A M I C S   D A T A
              FE          TOTAL EFFECTIVE FLATPLATE AREA               18.986      SQFT
              SWFT        TOTAL WETTED AREA                            1141.       SQFT
              CBARF       MEAN SKIN FRICTION COEFF.                    0.016638
        D R A G   B R E A K D O W N              IN  SQFT
              FEW         WING FE                                          0.731
              FEF         FUSELAGE FE                                     18.255
              FEFP        FORWARD(MAIN) ROTOR PYLON FE                     0.0
              FEAP        AFT ROTOR PYLON FE                               0.0
              FEMRH       MAIN ROTOR HUB(S) FE                             0.0
              FETRH       TAIL ROTOR HUB FE                                0.0
              FEVT        VERTICAL TAIL FE                                 0.0
              FEHT        HORIZONTAL TAIL FE                               0.0
              FEN         PRIMARY ENGINE NACELLE FE                        0.0
              FENI        AUX. INDEPENDENT CRUISE ENG. NAC. FE             0.0
              FENS        AUX. INDEPENDENT CRUISE ENG. STRUT FE            0.0
              DELTA FE    INCREMENTAL FE                                   0.0
A E R O D Y N A M I C   C O E F F .
              A5                                                         18.25549
              A6                                                          1.7244
              A7                                                          0.09420
              A8                                                          0.00312
              A9                                                          0.22743
              E       WING LIFT EFFICIENCY FACTOR                0.75000
              EVT     VERTICAL TAIL LIFT EFFICIENCY FACTOR       0.88000
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM 8-81

MISSION PERFORMANCE DATA

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRESS. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	AUX. TURB. TEMP. (R)	AUX. ENG. CODE	AUX. ENG. PEHF	AUX. ENG. FUEL FLOW (LBS/HR)	TEMP. DEG. (F)
0.0	0.0	0.0	17683.	0.	0.0	950.0	T	0.0	438.	950.0	T	0.0	95.	59.0
0.033	0.0	14.6	17668.	0.	0.0	950.0	T	0.0	436.	950.0	T	[illegible]	95.	59.0

TAKEOFF, HOVER, OR LAND AT T/W = 1.060 FOR 0.100 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	RHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRF RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CDO
0.033	0.0	14.6	17668.	0.	0.0	1685.7	P	0.625	1530.	1.06	0.735	2695.	0.093	0.073
725.0	2392.	690.0	319.	0.	1435.	95.	A		59.0	0.0	0.735	0.0011	0.079	0.068
0.053	0.0	45.2	17637.	0.	0.0	1684.2	C	0.623	1528.	1.06	0.736	2687.	0.0093	0.073
725.0	2386.	690.0	314.	0.	1433.	95.	A		59.0	0.0	0.735	0.0011	0.079	0.068
0.073	0.0	75.8	17607.	0.	0.0	1682.8	P	0.621	1525.	1.06	0.736	2679.	0.093	0.073
725.0	2379.	690.0	316.	0.	1430.	95.	A		59.0	0.0	0.735	0.0011	0.079	0.068
0.093	0.0	106.3	17576.	0.	0.0	1681.3	P	0.619	1522.	1.06	0.736	2670.	0.093	0.072
725.0	2372.	690.0	315.	0.	1427.	95.	A		59.0	0.0	0.735	0.0011	0.079	0.068
0.113	0.0	136.7	17546.	0.	0.0	1679.9	P	0.618	1519.	1.06	0.735	2662.	0.093	0.072
725.0	2365.	690.0	314.	0.	1424.	95.	A		59.0	0.	0.735	0.0011	0.079	0.068
0.133	0.0	167.1	17516.	0.	0.0	1678.5	P	0.616	1516.	1.06	0.735	2654.	0.092	0.072
725.0	2359.	690.0	313.	0.	1421.	95.	A		59.0	0.	0.735	0.0014	0.0079	0.068
0.133	0.0	167.1	17516.	0.	0.0	1678.5	P	0.616	1516.	1.06	0.736	2654.	0.092	0.072
725.0	2359.	690.0	313.	0.	1421.	95.	A		59.	0.	0.735	0.0011	0.079	0.068

CRUISE AT 17[illegible] KNOTS TAS. LIMITED BY NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	EHP

M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PERF		AUX. ENG. RHP OR THRUST
CPPRO	CPIMP	CPPAP	CPNUD	CDO	DELCDS	DELCDP	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
3.133	0.0	167.1	17516.	0.	170.0	1694.5	P	0.526	170.0	0.396	0.046	-5.[illegible]	.1[illegible]46	25[illegible].
725.0	2226.	641.[illegible]	156.	----	1291.	----	0.821	0.553	401.	1679.4	P	0.62[illegible]		1121.
0.000478	0.00[illegible]349	0.00[illegible]269	0.000942	0.01735	0.00012	0.00933	0.000517	A	----	----	----	0.56[illegible]	[illegible]7	.662
3.222	15.00	316.4	17366.	0.	170.0	1662.6	P	0.524	170.0	0.396	0.046	-5.[illegible]	.1[illegible]73	2539.
725.0	2210.	657.0	156.	----	1287.	----	0.821	0.55[illegible]	406.	1675.	P	0.61[illegible]		1121.
0.000476	0.000048	0.000269	0.000942	0.01727	0.0001[illegible]	0.00927	0.000516	A	----	----	----	0.56[illegible]	[illegible]7	.6[illegible]
3.31[illegible]	30.00	465.3	17217.	0.	170.0	1603.8	P	0.521	170.0	0.396	0.045	-5.1	.1[illegible]67	2526.
725.0	2208.	690.6	155.	----	1263.	----	0.821	0.553	40[illegible].	1676.5	P	0.616		1121.
0.000474	0.000047	0.000268	0.000941	0.01720	0.00009	0.00921	0.000516	A	----	----	----	0.506	0.067	0.677
3.398	45.00	613.6	17[illegible]69.	0.	170.0	1595.0	P	0.519	170.0	0.396	0.045	-5.1	.1[illegible]122	25[illegible].
725.0	2189.	690.0	155.	----	1280.	----	0.821	0.553	403.	1679.1	P	0.615		1121.
0.000472	0.000046	0.000265	0.000941	0.01713	0.0000[illegible]	0.00915	0.000515	A	----	----	----	.5[illegible]	[illegible]7	.674
3.486	60.00	762.[illegible]	16921.	0.	170.0	1597.2	P	0.517	170.0	.350	0.044	-5.2	10145	2566.
725.0	2175.	65[illegible]	154.	----	1276.	----	0.821	0.55[illegible]	4[illegible]	1677.6	P	0.617		1121.
0.000471	0.000044	0.000268	0.000940	0.01707	0.0000[illegible]	0.00[illegible]	0.000515	A	----	----	----	.5[illegible]	[illegible]7	.672

CLIMB TO 5000. FT. WITH MAXIMUM R/C AT NORMAL ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PERF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	EHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PERF		AUX. ENG. RHP OR THRUST	
CPPRO	CPIMP	CPPAP	CPNUD	CDO	DELCDS	DELCDP	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN	
0.48[illegible]	52.00	762.[illegible]	16921.	0.	76.4	1555.[illegible]	T	0.535	76.4	0.160	0.063	-2.4	7.3	1552.	1017.
725.0	1123.	65[illegible]	64.	----	198.	----	.62[illegible]	[illegible]	[illegible]	1856.	T	.135		[illegible]	
0.000152	[illegible]	[illegible]	[illegible]311	[illegible]	[illegible]	0.00347	0.00332	A	----	----	----	[illegible]3	[illegible]7	.[illegible]	
0.494	6[illegible].64	769.4	16913.	[illegible]	76.4	1556.[illegible]	T	[illegible].537	75.9	.16[illegible]	0.064	-2.3	[illegible]1	1032.	97[illegible].
725.0	1125.	[illegible]	64.	----	867.	----	0.820	0.6	6.	1556.[illegible]	T	0.137		[illegible]	
0.000153	0.000296	[illegible]	.0[illegible]11	0.0034	0.000[illegible]	0.00[illegible]1	0.00733	A	----	----	----	.3[illegible]	[illegible]7	.96	
0.563	61.30	777.[illegible]	16[illegible]6.	1[illegible]	76.4	1556.	T	[illegible]	75.3	.1[illegible]	[illegible]	-2.2	[illegible]	1312.	9[illegible].
725.0	1126.	[illegible]	6[illegible].	----	676.	----	.82[illegible]	[illegible]	0.	1856.	T	.07[illegible]		.	

0.000154	0.000213	0.000061	0.000011	0.0.836	0.0006	0.00055	0.000334	A	----	----	----	0.300	0.667	0.960	
0.512	61.99	754.6	16894.	1500.	77.4	1856.	T	0.841	75.2	0.183	0.065	-2.3	6.5	1891.	9 2.
725.0	1131.	690.3	63.	----	866.	----	0.820	0.0	0.	1856.0	T	0.84		0.	
0.000156	0.000216	0.000063	0.000012	0.0.845	0. 0000	0.00062	0.000342	A	----	----	----	0.30	0.67	0.96	
0.521	62.71	792.8	16891.	2000.	77.4	1856.0	T	0.841	75.2	0.183	0.067	-2.3	6.2	1870.	864.
725.0	1134.	655.1	63.	----	655.	----	0.820	0.0	0.	1856.0	T	0.841		0.	
0.000157	0.000223	0.000063	0.000012	0.0 850	0. 0001	0.00067	0.000343	A	----	----	----	0.300	0. 7	0.96	
0.531	63.47	801.	16882.	2500.	77.4	1856.	T	0.843	74.6	0.183	0.068	-2.3	5.9	1851.	826.
725.0	1138.	690.0	62.	----	844.	----	0.820	0.0	0.	1856.0	T	0.843		0.	
0.000157	0.000223	0.000064	0.000012	0.0.855	0.0001	0.00071	0.000344	A	----	----	----	0.30	0. 7	0.961	
0.541	64.26	809.5	16873.	3000.	78.4	1856.0	T	0.844	75.	.185	0.069	-2.3	5.6	1825.	787.
725.0	1142.	690.0	62.	----	834.	----	.820	0.0	0.	1856.	T	0.844		0.	
0.000160	0.000233	0.000066	0.000013	0.00864	0.00001	0.00086	0.000352	A	----	----	----	0.300	0.0 7	0.96	
0.551	65.17	818.7	16864.	3500.	78.4	1856.0	T	0.846	74.5	0.185	0.070	-2.3	5.3	1808.	747.
725.0	1146.	690.0	62.	----	823.	----	0.820	0.0	0.	1856.0	T	0.346		0.	
0.000161	0.000240	0.000066	0.000013	0.0 872	0.0001	0.00086	0.000357	A	----	----	----	0.300	0.667	0.961	
0.563	65.99	827.5	16855.	4000.	79.4	1856.	T	0.847	74.8	.187	0.071	-2.3	5.0	1788.	7 7.
725.	1151.	690.	62.	----	813.	----	0.820	0.0	0.	1856.0	T	0.847		0.	
0.000163	0.000244	0.000069	0.000013	0.00881	0.0002	0.00096	0.000361	A	----	----	----	.3	. 7	0.961	
0.574	66.94	837.1	16846.	4500.	79.4	1856.0	T	0.849	74.3	.187	0.072	-2.3	4.7	1767.	667.
725.0	1155.	690.0	62.	----	802.	----	.820	0.0	0.	1856.0	T	0.349		0.	
0.000165	0.000252	0.000069	0.000013	0.00889	0.00002	0.00103	0.000362	A	----	----	----	.3	. 7	0.961	
0.597	67.95	847.1	16835.	5000.	79.4	1856.0	T	0.851	73.7	.187	0.073	-2.2	4.4	1746.	626.
725.0	1156.	690.0	62.	----	792.	----	.820	0.0	0.	1856.0	T	0.850		0.	
0.000166	0.000260	0.000068	0.000014	0.00895	0.0002	0.00109	0.000363	A	----	----	----	.3	. 7	0.962	

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PERF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	SHP
M.ROTOR VTIP (FPS)	M.ROTOR RPM	T.ROTOR VTIP (FPS)	T.ROTOR RPM	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RPM AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PERF		AUX. ENG. SHP OR THRUST
CPPRO	CPIND	CPIAR	CPAUP	CDO	DELCDS	DELCDM	CTF	ROTLIM CODE	J	CP	CT	CL	CCU	LS
0.597	67.95	847.1	16835.	5000.	149.1	1517.6	P	0.846	138.4	.347	0.050	-2.8	.11845	1581.
725.	1619.	696.6	108.	----	884.	----	0.826	0.606	284.	1533.0	P	.471		545.
0.000412	0.001092	0.000152	0.001054	0.01450	0.0021	0.00843	0.002277	3	----	----	----	.6	0.057	0.7?1
0.607	2.95	575.8	16737.	5000.	149.1	1515.5	P	0.844	139.4	.347	0.054	-2.8	.11172	1677.
725.	1613.	690.	1 8.	----	997.	----	.826	0.6?	285.	1577.0	P	.471		549.
0.000410	0.000695	0.000152	0.000154	0.01647	0.0021	0.00867	0.002277	3	----	----	----	.6	. 7	.776

0.788	97.55	1104.4	16578.	5000.	149.1	1512.5	P	0.441	138.4	0.347	0.058	-2.8	.11712	186.
725.0	1600.	690.0	197.	----	989.	----	0.826	0.600	285.	1537.3	P	0.47		548.
0.000640	0.000388	0.000152	0.000053	0.01643	0.00018	0.00852	0.000370	A	----	----	----	0.500	0.07	.778
0.889	112.95	1232.5	16459.	5000.	149.1	1511.5	P	0.439	138.4	0.347	0.058	-2.9	.11745	185.
725.0	1551.	690.0	187.	----	986.	----	0.826	0.600	285.	1536.9	P	.47		548.
0.000486	0.000486	0.000152	0.000053	0.01633	0.00017	0.00826	0.000369	A	----	----	----	.50	.07	0.776
0.989	127.95	1363.2	16322.	5000.	149.1	1509.6	P	0.436	138.4	0.347	0.057	-2.9	.11777	184.
725.0	1581.	690.0	186.	----	983.	----	0.826	0.600	284.	1536.4	P	0.469		547.
0.000465	[illegible]	0.000152	0.000052	0.01626	0.00015	0.00821	0.000369	A	----	----	----	[illegible]	.07	0.774
1.090	142.95	1467.5	16195.	5000.	149.1	1507.7	P	0.434	138.4	0.347	0.056	-2.9	[illegible]	183.
725.0	1572.	690.0	186.	----	979.	----	0.826	0.600	284.	1536.0	P	0.469		546.
0.000403	0.000093	0.000152	0.000052	0.01620	0.00014	0.00815	0.000368	A	----	----	----	0.5	.07	0.772
1.137	150.00	1547.3	16135.	5000.	149.1	1506.8	P	0.433	138.4	.347	0.056	-2.9	.11825	182.
725.0	1568.	690.0	186.	----	978.	----	0.826	0.600	284.	1535.3	P	0.468		546.
0.000402	0.000082	0.000152	0.000051	0.01616	0.00014	0.00813	0.000368	A	----	----	----	0.5	.07	.772

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.137	150.00	1547.3	16135.	5000.
1.137	150.00	1547.3	16135.	1000.

TAKEOFF, HOVER, OR LAND AT T/W = 1.06 FOR 0.200 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PCHP	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	RFP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR PHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCP	FMT	CPURO	CPIMP	CDO
1.137	150.00	1547.3	16135.	1000.	0.0	1633.1	P	.564	1397.	1.06	.709	2550.	[illegible]	[illegible]
725.0	2106.	690.0	271.	[illegible]	1301.	92.	A		55.4	[illegible]	0.709	[illegible]	[illegible]	[illegible]
1.157	150.00	1575.1	16108.	1000.	0.0	1631.9	P	0.563	1395.	1.060	0.705	2543.	[illegible]	[illegible]
725.0	2100.	690.0	271.	[illegible]	1298.	92.	A		55.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.177	150.00	1602.9	16080.	1000.	0.0	1631.6	P	0.561	1398.	1.06	[illegible]	2536.	[illegible]	[illegible]
725.0	2095.	690.0	269.	[illegible]	1296.	92.	A		55.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.197	150.00	1630.7	16052.	1000.	0.0	1629.4	P	0.560	1396.	1.06	0.705	2530.	[illegible]	[illegible]
725.0	2089.	690.0	266.	[illegible]	1294.	92.	A		55.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.217	150.00	1658.4	16024.	1000.	0.0	1628.2	P	0.559	1393.	1.06	[illegible]	2523.	[illegible]	[illegible]
725.0	2083.	690.0	267.	[illegible]	1291.	92.	A		55.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.237	150.00	1686.1	15997.	1000.	0.0	1627.1	P	0.557	1381.	1.06	0.709	2516.	[illegible]	[illegible]
725.0	2078.	690.0	266.	[illegible]	1289.	92.	A		55.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.257	150.00	1713.7	15969.	1000.	0.0	1625.8	P	0.555	1379.	1.06	[illegible]	[illegible]	[illegible]	[illegible]
725.0	2072.	690.0	265.	[illegible]	1287.	92.	A		55.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1.277	15[illegible].00	1741.3	15541.	10.[illegible].	[illegible]	1624.6	F	.554	1377.	1.[illegible]6	[illegible].7[illegible]	25[illegible]4.	[illegible]87	[illegible]8
725.0	267.	6[illegible]	264.	[illegible].	1284.	92.	A		55.4	[illegible]	[illegible].75	[illegible]11	[illegible]7[illegible]	[illegible]8
1.297	15[illegible]	1764.[illegible]	15914.	10.[illegible].	[illegible]	1623.4	F	.552	1374.	1.68	0.709	2496.	[illegible]86	.68
725.0	261.	680.[illegible]	263.	[illegible].	1282.	92.	A		55.4	0.[illegible]	9.709	0.00011	9.[illegible]69	.[illegible]8
1.317	15[illegible].00	1796.[illegible]	15866.	10.[illegible].	[illegible]	1622.2	F	[illegible].551	137[illegible].	1.[illegible]6	[illegible].79	2469.	[illegible]86	.67
725.0	256.	680.0	262.	[illegible].	128[illegible].	92.	A		55.4	[illegible]	.79	[illegible]11	[illegible]6[illegible]	.68
1.337	15[illegible].00	182[illegible].7	158[illegible].	10.[illegible].	[illegible]	1621.1	F	.549	137[illegible].	1.6	.7[illegible]	2483.	[illegible].86	.67
725.0	2[illegible].	[illegible]	261.	.	127[illegible].	92.	A		55.4	0.[illegible]	0.709	0.00011	9.90969	9.9069
1.337	15[illegible].10	1823.7	15[illegible].	10[illegible].	[illegible]	1621.1	F	[illegible].549	137[illegible].	1.6	.79	2483.	[illegible]86	.67
725.0	25[illegible].	[illegible]	261.	[illegible].	1278.	92.	A		55.4	.	.79	[illegible]11	[illegible]69	[illegible]69

CHANGE PAYLOAD, REMOVE 1[illegible]. LB.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.337	159.66	1823.7	15[illegible].	1000.
1.347	15[illegible]	1823.7	14859.	1[illegible].

LOITER FOR [illegible] HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. CEUF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	RHF
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG. FUEL FLOW (LBS/HR)	RHP AUX	ETAP FCF	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. RERM		AUX. ENG. RHF OR THRUST
CPPRO	CPIT[illegible]	CPPAR	CPNUD	CDP	DELCDS	DELCDR	CXP	ROTLIM CODE	J	CE	CT	CLW	CDW	RM
1.347	15[illegible]	1823.7	14[illegible].	1[illegible].	7[illegible].6	137[illegible].	F	.24	74.5	.17[illegible]	[illegible]	-1.[illegible]	[illegible]	1.9[illegible].
725.0	[illegible].	6[illegible]	57.	----	514.	----	.[illegible]	.35	155.	1[illegible].7	P	.45		55.
0.00.150	.[illegible]162	0.[illegible]063	0.[illegible]09	0.0 P22	[illegible]	0.0[illegible]5	0.[illegible]0183	A	----	----	----	.4[illegible]	.[illegible]7	.842
1.397	15[illegible]	1872.2	14[illegible].	1[illegible].	7[illegible]	1374.4	F	0.24[illegible]	74.5	.17[illegible]	[illegible].56	-1.[illegible]	[illegible]	1.[illegible]2.
725.0	[illegible].	[illegible]	57.	----	[illegible].	----	.[illegible]	[illegible].35	15[illegible].	1[illegible]	P	.4[illegible]		[illegible].
0.00.150	.[illegible]16	.[illegible]	[illegible]	.1[illegible]22	[illegible]	[illegible]	[illegible]0.[illegible]3	A	----	----	----	.4	.[illegible]7	.842
1.447	1[illegible]	1[illegible]2.[illegible]	14[illegible]2.	1[illegible].	75.[illegible]	1373.[illegible]	F	[illegible].239	74.5	.17[illegible]	[illegible]	-1.[illegible]	5[illegible]7.	1.[illegible].
725.0	592.	[illegible].0	57.	----	512.	----	.[illegible]	[illegible]5	155.	1[illegible].7[illegible]	P	.45		55.
0.00.150	.[illegible]159	.[illegible]73	[illegible]	0.0 P22	.	[illegible]	0.[illegible]187	A	----	----	----	[illegible].4[illegible]	[illegible].[illegible]7	[illegible].842
1.497	1[illegible]	1[illegible]	14714.	1[illegible].	7[illegible].[illegible]	1373.2	P	.23[illegible]	74.5	.17[illegible]	.56	-1.[illegible]	[illegible]6.	1.[illegible].
725.	595.	[illegible]	57.	----	511.	----	.[illegible]	.35	15[illegible].	1[illegible]7[illegible]	P	.4[illegible]		[illegible].
0.00[illegible]0	0.0[illegible]	0.000073	[illegible]	[illegible] 522	..	[illegible]	[illegible].61[illegible]3	A	----	----	----	.4	.[illegible]7	.842
1.547	1[illegible]	[illegible]17.[illegible]	14[illegible].	1[illegible].	7[illegible].6	137[illegible]	F	.2[illegible]7	74.[illegible]	.17[illegible]	.[illegible]	-1.[illegible]	[illegible]5.	1[illegible].
725.0	5[illegible]6.	6[illegible]	57.	----	51[illegible].	----	.[illegible]	.35	155.	1[illegible]7.[illegible]	P	.45		[illegible].

0.000158	0.060157	0.000033	0.000009	0.00821	0.0	0.00038	0.000183	A	----	----	----	0.406	0.307		0.942
1.597	150.80	2065.5	14617.	1000.	75.6	1372.0	P	0.237	74.5	0.176	0.655	-1.5	964.		1979.
725.0	893.	690.0	57.	----	809.	----	0.839	0.350	155.	1267.5	P	0.043			55.
0.000150	0.000156	0.000632	0.000009	0.00821	0.0	0.00038	0.000182	A	----	----	----	0.400	0.307		0.942
1.647	150.80	2113.7	14569.	1000.	75.6	1371.4	P	0.236	74.5	0.176	0.055	-1.5	963.		1176.
725.0	890.	690.0	57.	----	808.	----	0.839	0.350	155.	1267.4	P	0.043			55.
0.000150	0.000155	0.000032	0.000009	0.00821	0.0	0.00037	0.000182	A	----	----	----	0.400	0.667		0.941
1.697	150.80	2161.9	14521.	1000.	75.6	1370.8	P	0.235	74.5	0.176	0.055	-1.5	962.		1173.
725.0	887.	690.0	57.	----	867.	----	0.839	0.350	155.	1207.4	P	0.043			55.
0.000150	0.000154	0.000632	0.000009	0.00821	0.0	0.00037	0.000182	A	----	----	----	0.400	0.307		0.941
1.747	150.80	2210.0	14473.	1000.	75.6	1370.2	P	0.235	74.5	0.176	0.055	-1.5	961.		1069.
725.0	884.	690.0	57.	----	807.	----	0.839	0.350	155.	1267.4	P	0.043			54.
0.000150	0.000153	0.000032	0.000009	0.00821	0.0	0.00037	0.000182	A	----	----	----	0.400	0.307		0.941
1.797	150.80	2258.1	14425.	1000.	75.6	1369.6	P	0.234	74.5	0.176	0.055	-1.5	960.		1066.
725.0	881.	690.0	56.	----	806.	----	0.839	0.350	155.	1207.3	P	0.043			54.
0.000150	0.000152	0.000032	0.000009	0.00821	0.0	0.00037	0.000182	A	----	----	----	0.400	0.307		0.941
1.847	150.80	2306.1	14376.	1000.	74.6	1369.3	P	0.233	73.5	0.174	0.654	-1.5	959.		1064.
725.0	878.	690.0	56.	----	865.	----	0.839	0.357	154.	1266.2	P	0.042			53.
0.000149	0.000153	0.000031	0.000009	0.00818	0.0	0.00034	0.000178	A	----	----	----	0.400	0.667		0.942

CLIMB TO 3000. FT. WITH MAXIMUM R/C AT NORMAL ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	BHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. RHP OR THRUST	
CPPRO	CPIND	CPFAP	CPNUD	CDO	DELCOS	DELCOM	CXR	RCTLIM CODE	J	CF	CT	CLW	CDW	RN	
1.847	150.60	2306.1	14376.	1000.	71.5	1856.0	T	0.838	70.5	0.169	0.055	-2.6	11.3	1509.	1468.
725.0	945.	690.0	58.	----	876.	----	0.820	0.0	0.	1856.	T	0.638		0.	
0.000147	0.000159	0.000054	0.000036	0.00813	0.0	0.00039	0.000317	A	----	----	----	0.41	0.007	0.945	
1.853	150.41	2311.1	14372.	1500.	71.5	1856.0	T	0.840	70.0	0.169	0.055	-2.6	11.0	1988.	1425.
725.0	945.	690.0	57.	----	865.	----	0.821	0.0	0.	1856.0	T	0.640		0.	
0.000147	0.000164	0.000054	0.000308	0.00815	0.0	0.00033	0.000318	A	----	----	----	0.400	0.007	0.946	
1.859	150.84	2316.1	14366.	2000.	72.5	1856.0	T	0.841	70.4	0.171	0.056	-2.6	10.6	1988.	1389.
725.0	947.	690.0	57.	----	854.	----	0.820	0.0	0.	1856.0	T	0.641		0.	
0.000149	0.000166	0.000056	0.000309	0.00829	0.0	0.00038	0.000326	A	----	----	----	0.400	0.007	0.946	
1.865	151.28	2321.2	14361.	2500.	72.5	1856.0	T	0.843	69.9	0.171	0.057	-2.6	10.3	1947.	1348.
725.0	948.	690.0	57.	----	844.	----	0.82	0.0	0.	1856.	T	0.643		0.	
0.000149	0.000171	0.000057	0.000009	0.00823	0.0	0.00041	0.000327	A	----	----	----	0.400	0.007	0.945	

1.871	151.73	2326.4	14356.	3000.	72.5	1856.0	T	0.644	69.4	0.171	0.058	-2.5	1..0	1827. 1306.
725.0	949.	690.0	56.	----	833.	----	0.820	0.0	0.	1856.0	T	3.844		0.
0.000150	0.000176	0.000057	0.000009	0.0.826	0.	0.00044	0.00328	A	----	----	----	0.410	0..07	.947

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PCHF		EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPFC. RANGE (NMPP)	PHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PCHF		AUX. ENG. RHF OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCOM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
1.871	151.73	2326.4	14356.	3000.	150.1	1460.0	P	0.367	143.6	0.349	0.044	-2.8	.11794	1616.
725.0	1370.	690.0	100.	----	939.	----	0.826	0.700	335.	1605.2	P	0.547		673.
0.000361	0.000650	0.000114	0.000041	0.01443	0.00001	0.00652	0.000273	A	----	----	----	0.500	0..07	0.724
1.971	166.73	2453.6	14229.	3000.	150.1	1458.6	P	0.362	143.6	.349	0.044	-2.8	.11819	1608.
725.0	1363.	690.0	100.	----	936.	----	0.826	0.700	335.	1606.7	P	0.547		673.
0.000360	0.000649	0.000113	0.000040	.01438	0.00001	0.00647	0.000273	A	----	----	----	0.50	0..07	.721
2.071	181.73	2580.5	14102.	3000.	150.1	1457.3	P	0.360	143.6	.349	0.043	-2.8	.11844	1601.
725.0	1356.	690.0	100.	----	934.	----	0.826	0.700	334.	1608.2	P	0.546		672.
0.000359	0.000048	0.000113	0.000040	0.01434	0.00001	0.00643	0.000272	A	----	----	----	0.50	0..07	.719
2.171	196.73	2707.2	13975.	3000.	150.1	1455.9	P	0.358	143.6	0.349	0.043	-2.9	.11869	1593.
725.0	1349.	690.0	100.	----	931.	----	0.826	0.700	334.	1607.7	P	0.546		671.
0.000357	0.000047	0.000113	0.000039	0.01429	0.00000	0.00639	0.000272	A	----	----	----	0.500	0..07	0.716
2.271	211.73	2833.5	13849.	3000.	150.1	1454.5	P	0.357	143.6	0.349	0.042	-2.9	.11894	1586.
725.0	1342.	690.0	99.	----	929.	----	0.826	0.700	334.	1607.3	P	0.545		670.
0.000356	0.000045	0.000113	0.000039	0.01425	0.00000	0.00634	0.000272	A	----	----	----	0.503	0..07	0.713
2.371	226.73	2959.7	13723.	3000.	150.1	1453.2	P	0.355	143.6	0.349	0.041	-2.9	.11919	1579.
725.0	1335.	690.0	99.	----	927.	----	0.826	0.700	334.	1606.6	P	0.544		670.
0.000355	0.000044	0.000113	0.000038	0.01421	0.00000	0.00630	0.000271	A	----	----	----	0.500	0..07	0.711
2.471	241.73	3085.8	13597.	3000.	150.1	1451.9	P	0.353	143.6	0.349	0.041	-3.0	.11943	1571.
725.0	1328.	690.0	99.	----	924.	----	0.826	0.700	333.	1606.3	P	0.544		669.
0.000354	0.000043	0.000113	0.000036	0.01416	0.0000	0.00626	0.000271	A	----	----	----	0.5	0..07	.7
2.570	256.73	3211.1	13471.	3000.	150.1	1450.6	P	0.352	143.6	.349	0.040	-3.	.11968	1564.
725.0	1321.	690.0	99.	----	922.	----	0.826	0.700	333.	1605.7	P	0.543		666.
0.000353	0.000042	0.000113	0.000037	0.01412	0.0000	0.00622	0.000271	A	----	----	----	.5	0..07	0.7
2.670	271.73	3336.5	13346.	3000.	150.1	1449.3	P	0.35	143.6	.349	0.04	-3.0	.11991	1557.
725.0	1314.	690.0	99.	----	920.	----	.826	0.700	333.	1605.4	P	0.543		668.
0.000352	0.000041	0.000113	0.000037	0.01408	0.0000	0.00617	0.000271	A	----	----	----	0.5	0..07	.7
2.770	286.73	3461.5	13221.	3000.	150.1	1448.0	P	0.348	143.6	0.349	0.039	-3.1	.12016	155 .

725.0	1394.	650.6	96.	----	516.	----	0.826	0.700	333.	1604.9	P	.542		667.
0.000361	0.000043	0.000112	0.000036	0.01403	0.0000	0.00613	0.000279	A	----	----	----	[illegible]	.97	0.700
2.859	300.00	3572.0	13111.	3 [illegible]	150.1	1446.9	P	0.347	143.6	.349	.33	-3.1	.1297	1547.
725.	1372.	690.6	98.	----	916.	----	0.826	0.700	332.	1604.5	P	.542		[illegible]
0.000359	0.000039	0.000112	0.000036	0.01400	0.000	0.0061	0.000279	A	----	----	----	[illegible]	.97	0.697

LOITER FOR 0.250 HRS. FOR RESERVE FUEL

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. DEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	SHP
M.ROTOR VTIP (FPS)	M.ROTOR KHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PRIP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAE PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. TEMP		AUX. ENG. SHP OR THRUST
CPPRO	CFIMO	CFPAR	CPNUD	CDO	DELCOS	DELCOM	CXP	ROTLIM CODE	J	CP	CT	CLW	CPW	FM
2.859	3[illegible]	3572.0	13111.	3 [illegible]	73.1	1361.3	P	0.277	69.9	.17	[illegible]	-2.0	627.	1[illegible]4.
725.0	843.	[illegible]	53.	----	760.	----	0.835	0.0	78.	959.1	P	.		.
0.000148	0.000146	0.000[illegible]	0.000000	.0.[illegible]2	.	0.[illegible]37	0.[illegible]0264	A	----	----	----	.4	.7	.542
2.908	3[illegible]	3[illegible]7.8	13[illegible]	3[illegible]	73.1	1346.8	P	0.236	69.9	.17	.[illegible]2	-2.2	636.	1[illegible]
725.0	841.	[illegible]	53.	----	759.	----	.634	0.[illegible]	7[illegible]	52.1	P	.		.
0.000148	0.0[illegible]145	0.[illegible]45	0.[illegible]	.0.820	.	0.[illegible]37	0.[illegible]0263	A	----	----	----	.4	.7	.542
2.959	300.00	3[illegible]	13127.	3[illegible]	73.1	136[illegible]	P	0.236	69.9	.17	.52	-2.3	636.	1[illegible]
725.0	838.	[illegible]	53.	----	758.	----	.634	0.[illegible]	78.	52.1	P	0.0		.
0.000148	0.0[illegible]144	0.[illegible]45	0.[illegible]	.0.82	0.	0.[illegible]36	0.[illegible]0263	A	----	----	----	.4	.7	.542
3.009	300.00	3697.4	12988.	3[illegible]	73.1	1358.7	P	0.235	69.9	.17	.52	-2.3	635.	1[illegible]
725.0	835.	64[illegible]	53.	----	757.	----	.630	0.[illegible]	78.	52.1	P	.		.
0.000148	0.0[illegible]143	0.[illegible]45	0.[illegible]	0.0.829	0.0	0.000[illegible]	0.000263	A	----	----	----	0.401	0.97	0.542
3.059	3[illegible]	3[illegible]2	12[illegible]4.	3 [illegible]	73.1	135[illegible]	P	0.234	69.9	.17	.52	-2.3	636.	1[illegible]
725.0	833.	[illegible]	53.	----	756.	----	.634	0.	78.	52.1	P	.		.
0.000146	0.0[illegible]142	0.[illegible]45	0.[illegible]	.0.82	0.	0.[illegible]	0.[illegible]0263	A	----	----	----	.4	.7	.542
3.109	3[illegible]	3[illegible]6	129[illegible]	3 [illegible]	73.1	13[illegible]6	P	0.237	69.6	.17	0.5[illegible]	-2.0	6[illegible]	1[illegible]
725.0	83[illegible]	[illegible]	53.	----	755.	----	.633	0.	7[illegible]	[illegible]	P	.		.
0.000147	0.0[illegible]144	0.[illegible]44	0.0[illegible]7	.0.817	0.	0.[illegible]34	0.[illegible]0267	A	----	----	----	.4	.7	.542

MISSION FUEL REQUIRED = 3571.36
RESERVE FUEL REQUIRED = [illegible]
TOTAL FUEL REQUIRED = 37[illegible]4

****

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                                   H E S C O M P
              HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    8-81

          THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

     LOC.  CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
     NUM   STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
     VAL   EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
     VAL1          VALUE              CORRESPONDING TO LOC.+001
     VAL2          VALUE              CORRESPONDING TO LOC.+002
           ETC.

      LOC.      NUM         VAL            VAL1            VAL2            VAL3            VAL4

          NOTE : IN USING AUXILIARY ENGINES : AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED
          BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

        !       1        ..
     WG = 0.250000E+05  WEA = 0.372065E+04  WFF = 0.378 6AE+04
```

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   R-91

SINGLE ROTOR COMPOUND HELICOPTER AUX. INDEPENDENT T/SHAFT CRUISE PROPULSION

S I Z E   D A T A   THIS RUN CONVERGED IN 0 ITERATIONS

GROSS WEIGHT = 25000. LB

FUSELAGE

LF	LENGTH(BODY+TAILBOOM)	56.5 FT.
LC	LENGTH(CABIN)	12.0 FT.
LB	LENGTH(BODY)	27.5 FT.
LTB	LENGTH(TAILBOOM)	29.0 FT.
XM	FWD. ROTOR LOCATION	15.1 FT.
WF	WIDTH	6.5 FT.
SF	WETTED AREA	882.9 SQ. FT.

WING

AR	ASPECT RATIO	4.51
SW	AREA	160.6 SQ. FT.
BW	SPAN	26.9 FT.
CBARW	MEAN CHORD	6.0 FT.
LAMBDA C/4	QUARTER CHORD SWEEP	0.0 DEG.
LAMBDA	TAPER RATIO	0.500
(T/C)R	ROOT THICKNESS/CHORD	0.200
(T/C)T	TIP THICKNESS/CHORD	0.120
WG/SW	WING LOADING	155.7 LBS/SQ. FT.
GRW	ROTOR/WING GAP	8.6 FT.
CF/C	FLAP CHORD/MEAN CHORD RATIO	1.000

HOR. TAIL

ARHT	ASPECT RATIO	4.000
SHT	AREA	50.3 SQ. FT.
BHT	SPAN	14.2 FT.
CHARHT	MEAN CHORD	3.5 FT.
LAMBDA H	TAPER RATIO	.500
(T/C)HT	THICKNESS/CHORD	0.120
LTH	HOR. TAIL ARM	30.9 FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.569
SVT	AREA	29.1 SQ. FT.
BVT	SPAN	6.8 FT.
CBARVT	MEAN CHORD	4.3 FT.
LAMBDA VT	TAPER RATIO	.457
ZTR	TAIL ROTOR(VERT.) LOCATION	5.5 FT.
ZETAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	0.600

(T/C)VT	THICKNESS/CHORD	.15

MAIN ROTOR PYLON

AP	ASPECT RATIO	.5[illegible]
SFP	WETTED AREA	39.1 SQ. FT.
FAFP	FRONTAL AREA	6.2 SQ. FT.
HPI	HEIGHT	3.[illegible] FT.
CHARFF	MEAN CHORD	6.3 FT.
LAMBDA FP	TAPER RATIO	.4[illegible]
(T/C)R	ROOT THICKNESS/CHORD	.4[illegible]
(T/C)T	TIP THICKNESS/CHORD	.2[illegible]

PRIMARY ENGINE NACELLE

LN	LENGTH	6.4 FT.
DN	MEAN DIAMETER	2. FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	[illegible] SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE

LNI	LENGTH	5.1 FT.
DNI	MEAN DIAMETER	1. FT.
SNI	WETTED AREA(TOTAL FOR ALL ENGINES)	22. SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE STRUT

SNIS	WETTED AREA(TOTAL)	6. SQ. FT.
BNS	SPAN	.1 FT.
CNS	MEAN CHORD	2.2 FT.

PROPELLER(AUXILIARY PROPULSION)

DAP	DIAMETER	1[illegible]. FT.
AF	ACTIVITY FACTOR PER BLADE	14[illegible]
SIGAP	SOLIDITY	.171
NPA	NO. OF PROPELLERS	1.
NO. BLADES	NO. OF BLADES/PROP	3.
VTIP	TIP SPEED	[illegible]. FT./SEC

MAIN ROTOR

DMR	DIAMETER	53.[illegible] FT.
SIGMR	SOLIDITY	[illegible].129
WG/A	DISC LOADING	11.[illegible] LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	[illegible].11[illegible]
NR	NO. OF ROTORS	1.
NO. BLADES	NO. OF BLADES/ROTOR	4.
THETA	BLADE TWIST	-[illegible] DEG.
XC	BLADE CUTOUT/RADIUS RATIO	.25
VTIP	TIP SPEED	725. FT./SEC.

TAIL ROTOR

DTR	DIAMETER	12.[illegible] FT.
SIGTR	SOLIDITY	.241
(T/A)NET	NET DISC LOADING	17.7 LB./SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	.17[illegible]
NO. BLADES	NO. OF BLADES/ROTOR	5.
THETA	BLADE TWIST	-4.[illegible] DEG.

```
XCTR          BLADE CUTOUT/RADIUS RATIO                      0.300
G             MAIN/TAIL ROTOR GAP                              1.0 FT.
VTIP          TIP SPEED                                      690. FT./SEC.

SAMPLE CASE NO. 1   RUN 2                                         PAGE   3

                         H I S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    8-91

  W E I G H T S   D A T A     IN LBS

          PLF          MANEUVER LOAD FACTOR                      3.500
          GLF          GUST LOAD FACTOR                          1.506
          ULF          ULTIMATE LOAD FACTOR                      5.250

       PROPULSION GROUP
              WPRG     TOTAL MAIN ROTOR GROUP                     2682.
          K12 WPRB         MAIN ROTOR BLADE (PER ROTOR)                 1616.
          K13 WPH          MAIN ROTOR HUB (PER ROTOR)                    715.
              WBF          BLADE FOLDING(PER ROTOR)                      355.
          K15 WAR      AUXILIARY PROPULSION ROTOR GROUP              0.
              WDS      DRIVE SYSTEM                               2332.
          K16 WRDS         MAIN ROTOR DRIVE SYSTEM                      1916.
          K20 WTRDS        TAIL ROTOR DRIVE SYSTEM                       181.
          K17 WAPS         AUXILIARY PROPULSION DRIVE SYSTEM             234.
          K18 WEP      PRIMARY ENGINES                            1 34.
          K19 WEA      AUXILIARY ENGINES                           248.
              WPEI     PRIMARY ENGINE INSTALLATION                 176.
              WAEI     AUXILIARY ENGINE INSTALLATION                42.
              WFS      FUEL SYSTEM                                 832.
          DELTA WP     PROPULSION GROUP WEIGHT INCREMENT             0.
                 WP   TOTAL PROPULSION GROUP WEIGHT                                 7346.

       STRUCTURES GROUP
          K5  WW       WING                                        331.
              WTG      TAIL GROUP                                  282.
          K5  WHT          HOR. TAIL                                     1 1.
          K14 WTR          TAIL ROTOR                                    162.
          K6  WF       FUSELAGE                                   24[illegible].
          K7  WLG      LANDING GEAR                               1 [illegible].
              WNG          NOSE GEAR                                     [illegible].
              WMG          MAIN GEAR                                     [illegible].
              WTES     TOTAL ENGINE SECTION                        235.
              WPES         PRIMARY ENGINE SECTION                        178.
              WAES         AUXILIARY ENGINE SECTION                       57.
          DELTA WST    STRUCTURE WEIGHT INCREMENT                    0.
                 WST  TOTAL STRUCTURE WEIGHT                                        4249.

       FLIGHT CONTROLS GROUP
              WFFC     PRIMARY FLIGHT CONTROLS                    1 59.
              WCC          COCKPIT CONTROLS                               54.
          K1  WRC          MAIN ROTOR CONTROLS                           613.
          K2  WSC          MAIN ROTOR SYSTEMS CONTROLS                   352.
          K3  WFW          FIXED WING CONTROLS                             .
```

```
KF  WSCA          AUX. PROPULSION ROTOR SYS. CONTROLS          0.
    WMC           MISCELLANEOUS CONTROLS                        0.
 DELTA WFC      CONTROL WEIGHT INCREMENT                1 0.
      WFC   TOTAL CONTROL WEIGHT                                     11.9.

WFE          WEIGHT OF FIXED EQUIPMENT                               12 .

WE           WEIGHT EMPTY                                         14984.

WFUL         FIXED USEFUL LOAD                                       45 .

OWE          OPERATING WEIGHT EMPTY                               15434.

WPL          PAYLOAD                                               2 0.

CWFIA        FUEL                                                  7516.

WG           GROSS WEIGHT                                         2  01.


SAMPLE CASE NO. 1   RUN 2                                          PAGE   4

                                      H E S C O M P
                HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    R-91


  R O T O R  D A T A

          ROTOR CYCLE NO.    3.0000

          MAIN ROTOR SOLIDITY SIZED BY MANUEVER CONDITIONS
          H =     3000.0 FT. , TEMP =      91.5 DEG. , V =      165.0 KT.
          100.0 PERCENT HOVER RPM
          ROTOR MANUEVER G'S =  1.353 , CT/SIGMA = 0.110

          TAIL ROTOR SIZED AT      1.050 TIMES THE SOLIDITY
          REQUIRED TO SATISFY HOVERING TURN REQUIREMENTS AT :
                         H                           =     4 00.0 FT.
                         TEMP                        =     95.035 DEG..F.
                         CTG/CTSET                   =      1.243
                         YAW RATE                    =      0.750 RAD/SEC.
                         YAW ACCELERATION            =      0.300 RAD/SEC2
                         TAIL ROTOR POLAR
                         MOM. OF INERTIA(PER BLADE)  =      8.621 SLUG/FT2
                         HELICOPTER YAW
                         MOM. OF INERTIA             =   61390.1 SLUG/FT2
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                    H F S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    6-91


P R O P U L S I O N   D A T A
      PRIMARY PROPULSION CYCLE NO.    1.761
            TURBOSHAFT ENGINE

            2.  ENGINES

      BHP.P          MAX. STANDARD S.L. STATIC H.P.          6593.     H.P.

      ENGINE SIZED FOR TAKEOFF AT T/W =1.06
       95.0 PERCENT MILITARY POWER SETTING,
      H = 4000. FT, TEMPERATURE = 95.04 DEG.F.,
       0.0   ENGINES INOPERATIVE, AND     0.0  FT/MIN VERTICAL RATE OF CLIMB.

      AUX. INDEPENDENT PROPULSION CYCLE NO.    1.761
            TURBOSHAFT ENGINE

            1.  ENGINES

      BHP.PT         MAX. STANDARD S.L. STATIC H.P.          1569.     H.P.

      ENGINE SIZED FOR CRUISE AT VC = 170. KNOTS,
       NORMAL  POWER SETTING,
      HC =  3000. FT, TEMPERATURE =  91.50 DEG.F.,
      AND  0.0   ENGINES INOPERATIVE.


            MAIN AND TAIL ROTOR DRIVE SYSTEM RATING          4711.     H.P.


            MAIN ROTOR DRIVE SYSTEM RATING          4088.     H.P.

      WHEN SIZED AT 100. PERCENT OF MAIN ROTOR HOVER POWER REQUIRED
      AT H = 4000. FT, TEMP = 95.04 DEG.F., 100.0 PERCENT HOVER RPM

            TAIL ROTOR DRIVE SYSTEM RATING          623.     H.P.

      WHEN SIZED AT 100. PERCENT OF TAIL ROTOR HOVER POWER REQUIRED
      AT H = 4000. FT, TEMP = 95.04 DEG.F., 100.0 PERCENT HOVER RPM

            AUXILIARY INDEPENDENT PROPULSION DRIVE SYSTEM RATING          0.     H.P.

      WHEN SIZED AT 100. PERCENT OF AUX. PROPULSION CRUISE POWER REQUIRED AT VC =170. KT.
      HC =  3000. FT, TEMP= 91.50 DEG.F.
```

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                              H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM     R-91

A E R O D Y N A M I C S   D A T A
        FF          TOTAL EFFECTIVE FLATPLATE AREA         23.128     SQFT
        SWET        TOTAL WETTED AREA                       1440.     SQFT
        CBARF       MEAN SKIN FRICTION COEFF.            0.016365
      D R A G   B R E A K D O W N        IN  SQFT
        FEW         WING FE                                    1.004
        FFF         FUSELAGE FE                               22.124
        FEFP        FORWARD(MAIN) ROTOR PYLON FE                 0.0
        FEAP        AFT ROTOR PYLON FE                           0.0
        FEMRH       MAIN ROTOR HUB(S) FE                         0.0
        FETRH       TAIL ROTOR HUB FE                            0.0
        FEVT        VERTICAL TAIL FE                             0.0
        FEHT        HORIZONTAL TAIL FE                           0.0
        FEN         PRIMARY ENGINE NACELLE FE                    0.0
        FENI        AUX. INDEPENDENT CRUISE ENG. NAC. FE         0.0
        FENS        AUX. INDEPENDENT CRUISE ENG. STRUT FE        0.0
        DELTA FE    INCREMENTAL FE                               0.0
A E R O D Y N A M I C   C O E F F .
        A5                                                22.12389
        A6                                                 1.04259
        A7                                                 0.09423
        A8                                                 0.06007
        A9                                                 0.23985
        E       WING LIFT EFFICIENCY FACTOR             0.75000
        EVT     VERTICAL TAIL LIFT EFFICIENCY FACTOR    0.87687
```

7.3.2 Tandem Rotor Winged Helicopter

The design mission profile is illustrated in Figure 7-2. The engine and rotor cycles are not discussed in this case. A complete copy of the program printout follows the description of the input.

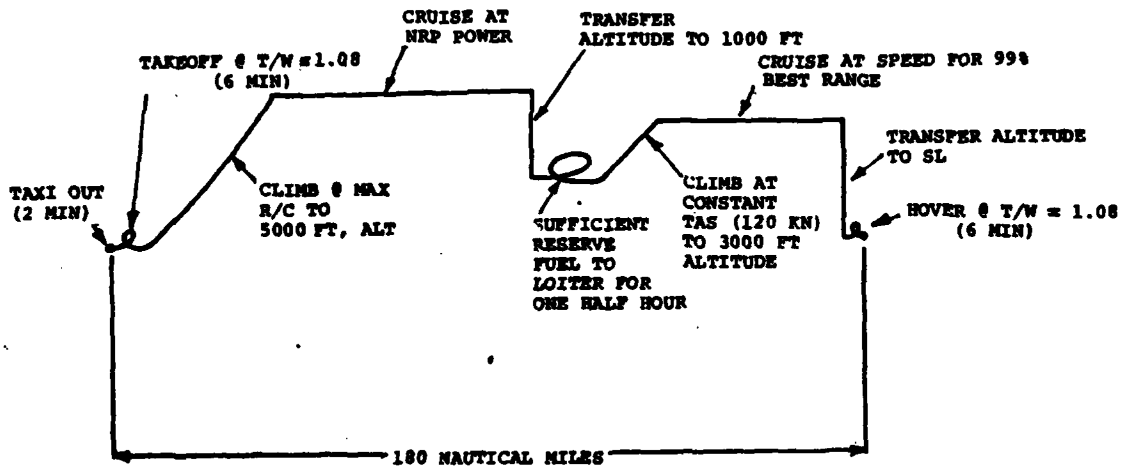

Figure 7-2. Design Mission - Sample Case No. 2

SAMPLE CASE NO. 2

GENERAL INFORMATION SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
OPTIND	0001	1.0	Sizing run
OPTIONAL PRINT	0002	1.0	Detailed printout desired
DRGIND	0003	1.0	Component drag build-up desired
OSWIND	0004	0	User inputs Oswald efficiency factor
CNFIND	0005	2.0	Tandem rotor helicopter
AUXIND	0006	2.0	Winged helicopter
RDMIND	0007	4.0	Main rotor diameter sized based on input disc loading; solidity sized based on input C_T/σ
FIXIND	0008	1.0	Program sizes primary engines
ROTIND	0009	1.0	Short form rotor performance method used
S_WIND	0010	3.0	Wing area sized by maneuver conditions
b_WIND	0011	2.0	Wing span sized by input aspect ratio
AIPIND	0012	1.0	No independent aux. engines
FDMIND	0020	2.0	Tandem rotor fuselage sized by input of ℓ_c and ((O/L)/D)
APHIND	0021	2.0	Aft rotor pylon geometry calculated based on input rotor gap/stagger ratio

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ESCIND	0022	2.0	Primary engines sized for either takeoff or cruise
WG_O	0023	30000	First guess at design gross weight
h_O	0024	0	Start altitude } Normally 0 except for partial mission analysis
R_O	0025	0	Starting range } Normally 0 except for partial mission analysis
t_O	0026	0	Starting time } Normally 0 except for partial mission analysis
$h_{OPT}IND$	0027	0	Cruise at specified altitudes
M_{MO}	0028	0.32	Maximum operating Mach number
V_{MO}	0029	200	Maximum operating EAS knots
V_{DIVE}	0030	200	Design dive speed, knots EAS
M_{LF}	0031	3.0	Maneuver load factor
K_1	0032	1.0	Factor on mission fuel burned to give reserve fuel; i.e., 1.1 would give 10 percent reserves
δW_f	0033	0.0	Fixed fuel increment for reserves or other use
K_{FF}	0034	1.05	Increase basic engine SFC by 5 percent

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
SGTIND	0035	1.0	Taxi	Sequence of Design Mission
	0036	2.0	Takeoff	
	0037	3.0	Climb	
	0038	4.0	Cruise	
	0039	9.0	Transfer altitude	
	0040	60.0	Loiter (reserve fuel)	
	0041	3.0	Climb	
	0042	4.0	Cruise	
	0043	9.0	Transfer altitude	
	0044	2.0	Hover and land	
	0045	100	End of case	

HELICOPTER DIMENSIONAL INFORMATION SHEET

AR	0104	6.0	Wing aspect ratio (input because b_WIND = 2.0)
$(t/c)_R$	0105	0.20	Wing root thickness/chord ratio
$(t/c)_T$	0106	0.12	Wing tip thickness/chord ratio
$\Lambda c/4$	0107	0	Quarter-chord mean sweep angle, degrees
λ	0108	0.5	Wing taper ratio
C_F/C	0109	1.0	Ratio of download alleviating flap chord to wing chord (1.0 signifies a fully tilting wing)

VARIABLE	LOC	VALUE	REMARKS
h'/h_F	0110	1.0	Wing located at top of fuselage
C_{L_D}	0111	1.2	Wing design lift coefficient
$\Delta S_{WET}/S_F$	0120	.0	Incremental wetted area of airplane ratioed to fuselage wetted area.
ΔS_{WET}	0121	.0	Incremental wetted area of aircraft (ft^2)
h_F	0122	7.0	Fuselage height
W_F	0123	6.5	Fuselage width
$(\ell/d)_P$	0124	0.70	Fineness ratio of nose
$(\ell/d)_T$	0125	1.2	Fineness ratio of tail
ℓ_C	0126	35.0	Constant diameter section length
ℓ_{RW}	0127	5.0	Length of ramp well
$((O/L)/D)$	0132	0.22	Tandem rotor overlap/diameter ratio
Z_1	0142	0.035	Primary engine nacelle constants
Z_2	0143	2.0	
Z_3	0144	0.078	
ℓ_{AIP}/ℓ_C	0145	.0	Ratio of air induction system length to engine length (primary engines)
$(t/c)_{R_F}$	0152	0.45	Forward rotor pylon root thickness/chord ratio
$(t/c)_{T_F}$	0153	0.25	Forward rotor pylon tip thickness/chord ratio
AR_{FP}	0154	0.4	Forward rotor pylon aspect ratio
λ_{FP}	0155	0.7	Forward rotor pylon taper ratio

VARIABLE	LOC	VALUE	REMARKS
h_{P_1}	0156	3.0	Forward rotor pylon height
$(t/c)_{R_A}$	0157	0.50	Aft rotor pylon root thickness/chord ratio
$(t/c)_{T_A}$	0158	0.30	Aft rotor pylon tip thickness/chord ratio
AR_{AP}	0159	0.7	Aft rotor pylon aspect ratio
λ_{AP}	0160	0.75	Aft rotor pylon taper ratio
g/s	0162	0.16	Tandem rotor gap/stagger ratio (input because APHIND = 2.0)

MAIN ROTOR DIMENSIONAL DATA SHEET

VARIABLE	LOC	VALUE	REMARKS
ROTOR CYCLE NO.	0171	3.0	Rotor blade section aerodynamic characteristics selection
N_R	0172	2.0	No. of rotors
W/A	0173	8.0	Disc loading
b_{MR}	0176	4.0	No. of blades/main rotor
$\theta_{T_{MR}}$	0177	-9.0	Main rotor twist (deg)
$X_{C_{MR}}$	0178	0.2	Main rotor blade cutout as a fraction of radius
X_{MR}	0179	0.075	Main rotor blade attachment point as a fraction of radius
$(t/c)_{.25R}$	0180	0.12	Rotor blade thickness/chord at 25 percent radius

VARIABLE	LOC	VALUE	REMARKS
V_{TIP}	0181	700	Main rotor tip speed
$(C_T/\sigma)_H$	0182	0.12	Rotor "lift coefficient" for hover sizing rotor solidity
T/W	0183	1.08	Rotor design thrust/ weight ratio
$V_{KT}(c)$	0184	160	Cruise flight con ditions for sizing rotor solidity
$h_c(c)$	0185	4000	
ΔT_{IN_C}	0186	0	
$(C_T/\sigma)_{CR}$	0187	0.095	Rotor "lift coefficient" for sizing rotor solid- ity in cruise flight
g REQM'T	0188	2.0	Total g requirement helicopter must satisfy at $V_{KT}(c)$
g(ROTOR)	0189	1.5	Maneuver g's carried by main rotor at $V_{KT}(c)$
N (ROTOR LOADING)	0190	1.0	Rotor lift/GW for 1g cruise flight rotor solidity sizing
V_{CEH1}	0191	1.53	Main rotor vertical rate-of-climb efficiency factors
V_{CEH2}	0192	0.0	
$K_{P_{CLIMB}}$	0193	0.85	Helicopter forward flight climb efficiency
ΔF.M.	0195	.0	Incremental figure of merit added to results obtained when using "short form method". Input only if ROTIND = 1

PRIMARY ENGINE SIZING INFORMATION SHEET

VARIABLE	LOC	VALUE	REMARKS
PRIMARY ENGINE CYCLE NO.	0217	1.761	Engine selection
N_P	0219	4.0	No. of primary engines
XMSNIND	0220	2.0	Drive system rated at power required to hover or cruise (more critical of the two conditions selected by program)
SHP_{MRX}/SHP^*_{MR}	0221	1.00	Main rotor drive system is rated at 100 percent of main rotor design power
η_T	0223	0.97	Transmission efficiency
ΔSHP_{ACC}	0224	100	Accessory power losses
$h_{TO}(H)$	0227	4000	Design point hover altitude (engine sizing)
$(T/W)_D$	0228	1.08	Configuration design point hover thrust/weight ratio
$\Delta T_{INTO}(H)$	0229	50.3	Increment in ambient temperature for engine sizing at takeoff conditions.
$(N_{II}/N_{II_{MAX}})_{TO}$	0230	1.105	Main rotor operating at 100 percent of hover tip speed (700 fps); i.e.

$$\left[\frac{N_{II}}{N_{II_{MAX}}}\right]_{TO} \left[\frac{N_{II_{MAX}}}{NII^*}\right] V_T$$

(LOC 0230) (LOC 1223) (LOC 0181)

$$= \underbrace{1.105\ (.905)}_{1.0}(700)$$

$$= 700$$

VARIABLE	LOC	VALUE	REMARKS
$N_{P_{SD}}$	0231	1.0	One engine inoperative at hover design point conditions
SHP_E/SHP^*	0232	0.95	Engines sized for hover (OGE) with 1 engine out and the remaining engines operating at 95% MRP
$(V_{R/C})D$	0233	.0	Design vertical rate of climb used in sizing primary engines.
POWIND	0234	2.0	Maximum engine rating for cruise engine sizing. For this example, normal rated power is the maximum rating to be used.
h_c	0235	3000	Design point (cruise) altitude (engine sizing)
V_c	0236	155	Design point cruise speed (kts) (engine sizing)
$C_{L_{D_P}}$	0240	0.45	Wing operating lift coefficient at cruise condition for engine sizing
$(N_{P_{SD}})_c$	0241	0.0	No. of primary engines shut down during cruise (for engine sizing)

HELICOPTER AERODYNAMICS INFORMATION SHEET

C_{DAP}	0303	.006	AFT rotor pylon profile drag coefficient at Re = 10^7 (based on aft pylon planform area)
C_{DFP}	0305	.15	Forward rotor pylon profile drag coefficient at Re = 10^7 (based on forward pylon max frontal area)
C_{DCSMR}	0305	.75	Main rotor hub center section profile drag coefficient (based on center section frontal area)
CD_{SHMR}	0306	1.4	Main rotor hub shank profile drag coefficient (based on shank frontal area)

VARIABLE	LOC	VALUE	REMARKS
C_{D_N}	0309	.0032	Profile drag coefficient of primary engine nacelles at Re = 10^7 (based on wetted area of all nacelles)
e	0314	.75	Span loading efficiency factor
ΔF_e FT^2	0316	5.5	Increment in equivalent flat plate area parasite drag of fuesalage (ft^2)
K_{AP}	0319	1.045	Aft rotor pylon multiplicative drag factor
K_{FP}	0320	1.25	Forward rotor pylon multiplicative drag factor
K_{HPIM}	0321	1.3	Main rotor hub/shank multiplicative drag factor
K_N	0323	2.86	Primary nacelle multiplicative drag factor
K_F	0326	1.25	Fuselage multiplicative drag factor
K_W	0327	1.54	Wing multiplicative drag factor
$(Re/\ell)i$	0328	.1544(10^7)	Mean Reynolds number per foot for mission
C_{ℓ_α}RAD-1	0329	6.28	Two-dimensional wing lift coefficient slope
NO. OF PAIRS IN TABLE C_{LW}	0330	6.0	Number of C_{LW} pairs input in locations 0331 - 0346
$C_{LW}(1)$	0331	.0	Wing lift coefficients
	0332	.2	
	0333	.4	
	0334	.6	
	0335	.8	
$C_{LW}(6)$	0336	.10	

VARIABLE	LOC	VALUE	REMARKS
$C_{DWi}(1)$	0339	.59E-02	Profile drag coefficient of wing at Re = 10^7 (based on wing planform area)
↓	0340	.006	
	0341	.0068	
	0342	.008	
	0343	.0095	
$C_{DWi}(6)$	0344	.0116	
ROTOR LIMITS INFORMATION SHEET			
NO. OF CX/σ	0347	3.	Specifies number of CX/σ values in table locations 0349 - 0353
NO. OF μ	0348	3.	Specifies number of μ values in table locations 0354 - 0360
VALUES OF CX/σ	0349	0	Rotor propulsive thrust coefficient divided by main rotor solidity. Used in defining rotor limits. $CX/\sigma = \dfrac{\text{THRUST REQUIRED}}{\dfrac{\rho \Pi\ DMR^2 N_R V_{TIP}^2 \sigma_{MR}}{4}}$
	0350	.5	
	0351	1.0	
VALUES OF μ	0354	.0	Rotor forward flight advance ratio $\mu = \dfrac{V_{FPS}}{V_{TIP}}$
	0355	.5	
	0356	1.	
VALUES OF CT'/σ	0361	1.	Values of CT'/σ corresponding to $(CX/\sigma)_1$ location 0349 and μ_1, μ_2, and μ_3.
	0362	1.	
	0363	1.	

VARIABLE	LOC	VALUE	REMARKS
	0368	1.	Values of CT'/σ corresponding to $(CX/\sigma)_2$ location 0350 and μ_1, μ_2, and μ_3.
	0369	1.	
	0370	1.	
	0375	1.	Values of CT'/σ corresponding to $(CX/\sigma)_3$ location 0351 and μ_1, μ_2, and μ_3.
	0376	1.	
	0377	1.	

HELICOPTER WEIGHT INFORMATION SHEET

VARIABLE	LOC	VALUE	REMARKS
W_{FE}	2602	3000	Weight of fixed equipment in LBS
W_{FUL}	2603	600	Weight of fixed useful load in LBS
W_{PL}	2604	5000	Weight of payload in LBS
ΔW_{FC}	2605	.0	Flight controls group incremental weights in LBS.
ΔW_P	2606	.0	Propulsion group incremental weight in LBS
ΔW_{ST}	2607	.0	Structures group incremental weight in LBS
RM_1	2608	.0	Wing relief as percentage of GW
W_i	2609	.0	Weight of inboard store
W_o	2610	.0	Weight of outboard store
d_i	2611	.0	Position of inboard underwing store (fraction of wing semi-span)
d_o	2612	.0	Position of outboard underwing store (fraction of wing semi-span)
K_{CC}	2613	26.	Cockpit controls weight factor
K_{RC}	2614	18.	Main rotor controls weight factor

VARIABLE	LOC	VALUE	REMARKS
K_{SC}	2615	42.	Main rotor system controls weight factor
K_{FW}	2616	.0	Fixed wing controls
K_{TM}	2617	.0	Tilt mechanism weight factor
K_{SAS}	2618	100.	Stability Augmentation System (SAS) weight factor. Usually in the range of 20-100 pounds.
K_{RCA}	2619	.0	Auxiliary rotor controls weight factor
K_{SCA}	2620	.0	Auxiliary rotor systems controls weight factor
K_{MC}	2621	.0	Miscellaneous controls weight factor in LBS
K_B	2622	125.	Body group weights factor
ΔCG	2623	3.	Helicopter cg travel (FT)
K_{LG}	2624	.04	Landing gear weight factor input as percentage of gross weight
K_{MG}	2625	.8	Main landing gear weight factor
K_{WW}	2626	.0	Detailed wing weight factor. This adjusts the constant 220 in $W_W = 220(k)^{0.585}$ up or down depending on the complexity of the control surfaces
LF	2627	1.	Wing unload factor. Entered as a fraction of design gross weight
K_{WS}	2628	.0	Wing stores only weight trend factor
K_{WP}	2629	2.06	Wing weight/area factor (psf)
K_{HT}	2630	.0	Horizontal tail unit weight in psf
K_{CLF}	2631	.0	Crash load factor

VARIABLE	LOC	VALUE	REMARKS
K_{WAC}	2632	.0	Primary cowling weight factor (psf)
K_{AIP}	2633	120.	Primary air induction system weight factor
K_{NACA}	2634	.0	Auxiliary cowling weight factor (psf)
K_{AIA}	2635	.0	Auxiliary air induction system weight factor
K_{NS}	2636	.0	Nacelle strut weight factor
K_{PRB}	2637	44.	Primary rotor blade weight factor
K_{RBF}	2638	1.	Rotor type factor; hingeless for this example
K_{PH}	2639	61.	Primary hub weight factor
K_{AMD}	2640	1.	Main rotor weight factor
K_{BLFD}	2641	1.25	Blade fold weight factor. Input as a fractional part of the total rotor weight
K_{TR}	2642	.0	Tail rotor weight factor
K_{AR}	2643	.0	Auxiliary rotor weight factor. This is the average value for the rotor or propeller weight (LB). $W_R = 14.2a(k)^{.67}$
K_{PA}	2644	.0	Auxiliary rotor multiplicative input power, expressed here as 0% input power
K_{VTAR}	2645	.0	Auxiliary tail rotor multiplicative tip speed factor expressed here as 0% input speed
K_{PDS}	2646	.19	Primary drive system weight factor
K_{PDSZ}	2647	4.	Primary drive system weight factor. Number of gears in system
K_{TRDS}	2648	.0	Tail rotor drive system weight factor

VARIABLE	LOC	VALUE	REMARKS
K_{ADS}	2649	.0	Auxiliary drive system weight factor
K_{ADSZ}	2650	.0	Auxiliary drive system weight factor (number of gears in system)
K_{FS}	2651	.19	Fuel system weight factor
K_{PEI}	2652	200.	Primary engine installation weight factor
K_{AEI}	2653	.0	Auxiliary engine installation weight factor
K_1	2654	1.	Main rotor controls weight factor
K_2	2655	1.	Main rotor system controls weight multiplicative factor
K_3	2656	1.	Fixed wings controls weight multiplicative factor
K_4	2657	1.	Auxiliary rotor controls weight multiplicative factor
K_5	2658	1.	Auxiliary rotor system controls weight multiplicative factor
K_6	2659	1.	Body weight multiplicative factor
K_7	2660	1.	Landing gear weight multiplicative factor
K_8	2661	1.	Wing weight multiplicative factor
K_9	2662	1.	Horizontal tail weight multiplicative factor
K_{10}	2663	1.	Primary nacelle weight multiplicative factor
K_{11}	2664	1.	Auxiliary nacelle weight multiplicative factor
K_{12}	2665	1.	Primary rotor blade weight multiplicative factor

K_{13}	2666	1.	Primary rotor hub weight multiplicative factor
K_{14}	2667	1.	Tail rotor weight multiplicative factor
K_{15}	2668	1.	Auxiliary rotor weight multiplicative factor
K_{16}	2669	1.	Primary drive system weight multiplicative factor
K_{17}	2670	1.	Auxiliary drive system weight multiplicative factor
K_{18}	2671	1.	Primary engine weight multiplicative factor
K_{19}	2672	1.	Auxiliary engine weight multiplicative factor
K_{20}	2673	1.	Tail rotor drive system weight multiplicative factor

TAXI INFORMATION SHEET

ATMIND	0401	.0	Standard atmosphere selected
t_T	0411	0.0333	Taxi for 2 minutes
ΔT_{INTO}(°F)	0421	.0	Increment in ambient temperature for primary engine sizing at takeoff conditions
K_{FI}	0431	.0	Auxiliary independent engines fuel flow multiplicative factor (used in TAXI)
$(N_{II}/N_{II_{MAX}})$ (PRIM ENG)	0441	1.105	Operating point for engine power turbine during TAXI

$$\frac{N_{II}}{N_{II_{MAX}}} = \frac{V_{T_{OPERATING}}}{V_T \left(\frac{N_{I_{MAX}}}{N_{II}^*}\right)}$$

VARIABLE	LOC	VALUE	REMARKS
TAKEOFF, HOVER, AND LANDING INFORMATION SHEET			
TOLIND	0461	1.0	Specify required T/W for hover out of ground effect
	0462	1.0	
ATMIND	0481	.0	Standard atmosphere
ATMIND	0482	.0	
ΔT_{IN} (°F)	0501	.0	Incremental temperature above standard, in degrees
ΔT_{IN} (°F)	0502	.0	
$V_{R/C}$	0511	.0	0 ft/min vertical rate of climb capability desired
$V_{R/C}$	0512	.0	
T/W	0521	1.08	Hover thrust/weight ratio specified
T/W	0522	1.08	
Δt_H(HR)	0531	.01	Time increments for takeoff, hover or landing computations in hours
Δt_H(HR)	0532	.01	
$N_{II}/N_{II_{MAX}}$ PRIMARY ENGINE	0541	1.105	Operating point for engine power turbine during takeoff, hover or landing
$N_{II}/N_{II_{MAX}}$ PRIMARY ENGINE	0542	1.105	

$$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{TOHL} = \frac{V_{T_{OPERATING}}}{V_T \left(\frac{N_{II_{MAX}}}{N_{II}^*}\right)}$$

VARIABLE	LOC	VALUE	REMARKS
t_H	0551	0.1	Hover for 6 minutes
	0552	0.1	
CLIMB INFORMATION SHEET			
CLMIND	0571	1.0	Climb at maximum rate of climb
	0572	4.0	Climb at constant TAS

VARIABLE	LOC	VALUE	REMARKS
$MACH_{2nd}$	0582	120.0	Mach number required during climb
ATMIND	0591	.0	Standard atmosphere
ATMIND	0592	.0	
$C_{L_{WING}}$	0601	0.4	Wing operating C_L in climb
	0602	0.5	
ΔT_{IN} (°F)	0611	.0	Incremental temperature above standard, in degrees
ΔT_{IN} (°F)	0612	.0	
Δh (FT)	0621	500.	Altitude increments for climb calculations
	0622	500.	
POWIND	0631	2.0	Climb at normal engine power
POWIND	0632	2.0	
h_{MAX} (FT)	0641	5000.	Final altitudes for climb
h_{MAX} (FT)	0642	3000.	
$N_{II}/N_{II_{MAX}}$ PRIMARY ENG	0651	1.015	This location specifies the operating point for engine power turbine at design climb conditions
	0652	1.015	
ΔFe_{CL} (FT^2)	0661	.0	Increment in equivalent flat plate area parasite drag (climb performance segment)
	0662	.0	
$N_{P_{SD_{CL}}}$	0681	2.0	Shut down two of the primary engines in climb
	0682	2.0	
NPSD i_{CL}	0701	.0	Number of auxiliary independent engines shut down during climb
NPSD i_{CL}	0702	.0	

CRUISE INFORMATION SHEET

CRSIND	0721	1.0	Cruise at specified power setting
	0722	4.0	Cruise at 99 percent best range speed

VARIABLE	LOC	VALUE	REMARKS
$V_{IN_{2nd}}$	0732	25.0	True air speed for cruise during cruise segment with CRSIND = 2(kts)
ATMIND	0741	.0	Standard atmosphere
ATMIND	0742	.0	
$C_{L_{WING}}$	0751	0.4	Wing operating C_L in cruise
	0752	0.45	
ΔT_{IN} (°F)	0761	.0	Incremental temperature above standard in degrees
ΔT_{IN} (°F)	0762	.0	
ΔR(NM)	0771	20.0	Step size for cruise (nautical miles)
	0772	20.0	
POWIND	0781	2.0	Cruise at NRP for first cruise segment
R_{MAX}	0791	80	Values of range at end of each cruise
	0792	180	
$N_{II}/N_{II_{MAX}}$ (PRIMARY ENG)	0801	1.105	Specifies the operating point for engine power turbine at design cruise conditions
	0802	1.105	
ΔFe_{CR} (FT^2)	0811	.0	Increment in equivalent flat plate area parasite (cruise performance segment)
	0812	.0	
$N_{PSD_{CR}}$	0831	.0	Number of primary engines shut down during cruise
	0832	.0	

LOITER INFORMATION SHEET

ATMIND	1031	.0	Standard atmosphere
C_{LW}	1041	.4	Wing operating C_L in loiter
ΔT_{IN} (°F)	1051	.0	Incremental temperature above standard, in degrees
ΔT_L (HR)	1061	.05	Step size for loiter

VARIABLE	LOC	VALUE	REMARKS
$N_{II}/N_{II_{MAX}}$ (PRIMARY ENG)	1071	1.105	Specifies the operating point for engine power turbine at design loiter conditons
t_L	1081	.5	Incremental time for loiter
$N_{PSD_{LOITER}}$	1101	.0	Number of primary engines shut down during loiter
ΔFe_L	1131	.0	Increment in equivalent flat plate area parasite drag (loiter performance sector)
TRANSFER ALTITUDE	1181	1000.	Transfer altitude

ENGINE CYCLE DATA; NON-STANDARD PERFORMANCE

VARIABLE	LOC	VALUE	REMARKS
WDTIND	1201	.0	No fuel flow cutoffs
N1IND	1202	.0	No N_I cutoffs
N1θND	1203	.0	No referred N_I cutoff
N2IND	1204	2.	Free turbine engine to be simulated
Q_{IND}	1205	.0	No torque limit
RNOIND	1206	.0	No Reynolds No. corrections
$(N_{II_{MAX}}/N_{II}^*)$	1223	.905	Value for N_{II} cutoff referred to N_{II}^*

SAMPLE CASE NO 2. RUN 2.

VARIABLE	LOC	VALUE	REMARKS
OPTIONAL PRINT	2	.0	Standard print, no details

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-91

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+0001
VAL2 VALUE CORRESPONDING TO LOC.+0002
ETC.

NOTE : IN USING AUXILIARY ENGINES & AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
1281	5	.0	.0	.0	2.0000	.0
1286	1	.0				
1223	1	.90500				
1301	5	1.7610	.15900	.0	.32000E-01	950.00
1306	5	1100.0	1856.0	2000.0	2000.0	8.0000
1311	5	950.00	1200.0	1400.0	1600.0	1800.0
1316	5	2.0000	2200.0	2600.0	5.0000	.0
1321	4	.20000	.40000	.60000	.80000	
1326	5	.25000E-01	.25750E-01	.27800E-01	.31300E-01	.36200E-01
1332	5	.16300	.16760	.18130	.20410	.23600
1338	5	.33500	.34440	.37250	.41940	.48510
1344	5	.54400	.55920	.60490	.68110	.78770
1350	5	.77600	.79160	.85620	.96400	1.1150
1356	5	1.0000	1.0280	1.1120	1.2520	1.4480
1362	5	1.2000	1.2336	1.3344	1.5024	1.7376
1368	5	1.5500	1.5934	1.7236	1.9406	2.2444
1374	5	8.0000	950.00	1200.0	1400.0	1600.0
1379	5	1800.0	2000.0	2200.0	2600.0	5.0000
1384	5	.0	.20000	.40000	.60000	.80000
1390	5	.65000E-01	.65100E-01	.65300E-01	.67000E-01	.71000E-01
1396	5	.11500	.11600	.11800	.12800	.14500
1402	5	.18000	.18100	.19000	.20600	.22700
1408	5	.26000	.26100	.27300	.29500	.32500
1414	5	.34200	.34700	.36200	.38900	.42500
1420	5	.42500	.43500	.45100	.48600	.51700
1426	5	.50000	.51100	.53000	.56300	.61000
1432	5	.62600	.63100	.66000	.71800	.78[illegible]
1438	4	3.0000	950.00	1600.0	2600.0	
1447	4	3.0000	.0	.40000	.80000	
1454	3	.26300	.27100	.29300		
1460	3	.82000	.84000	.90000		
1466	3	1.0500	1.1160	1.1650		
1502	5	8.0000	950.00	1200.0	1400.0	1600.0
1507	5	1800.0	2000.0	2200.0	2600.0	5.0000
1512	5	.0	.20000	.40000	.60000	.80000
1518	5	.26000	.26500	.27100	.28000	.29000
1524	5	.52000	.52700	.54000	.56000	.59000
1530	5	.68000	.69000	.79500	.73900	.76000

1536	5	.82000	.82400	.84000	.86800	.90000
1542	5	.92000	.93000	.95000	.98000	1.0200
1548	5	1.0000	1.0020	1.0200	1.0500	1.0950
1554	5	1.0520	1.0558	1.0700	1.1000	1.1310
1560	5	1.0900	1.1000	1.1180	1.1350	1.1650
1601	2	3.0000	-9.0000			
1603	5	.79727E-02	-.26000E-01	.26200	.27600	2.4500
1606	1	.86500				
1609	5	.84134E-02	2.6200	.50000E-01	1.1700	.12400E-02
1614	2	.75800	.74300			
1616	5	10.000	.0	.40000E-02	.70000E-02	.90000E-02
1621	5	.10000E-01	.11500E-01	.11500E-01	.12000E-01	.15500E-01
1626	5	.22000E-01	1.0180	1.0850	1.1540	1.2330
1631	5	1.2790	1.3140	1.3270	1.3370	1.3640
1636	1	1.3970				
1	5	1.0000	1.0000	1.0000	.0	2.0000
6	5	2.0000	4.0000	1.0000	1.0000	3.0000
11	2	2.0000	1.0000			
20	5	2.0000	2.0000	2.0000	30000.	.0
25	5	.0	.0	.0	.32000	200.00
30	5	20.000	3.0000	1.0000	.0	1.0500
35	5	1.0000	2.0000	3.0000	4.0000	9.0000
40	5	60.000	3.0000	4.0000	9.0000	2.0000
45	1	10.000				
114	5	6.0000	.20000	.12000	.0	.50000
119	3	1.0000	1.0000	1.2000		
120	5	.0	.0	7.0000	6.5000	.70000
125	3	1.2000	35.000	5.0000		
132	1	.22000				
142	4	.35000E-01	2.0000	.78000E-01	.0	
152	5	.45000	.25000	.40000	.70000	3.0000
157	4	.50000	.30000	.70000	.75000	
162	1	.16000				
171	3	3.0000	2.0000	6.0000		
176	5	4.0000	-9.0000	.20000	.75000E-01	.12000
181	5	700.00	.12000	1.0800	160.00	4000.0
186	5	.0	.95000E-01	2.0000	1.5000	1.0000
191	4	1.5300	.0	.65000	.0	
217	1	1.7610				
219	3	4.0600	2.0000	1.0000		
223	2	.57000	100.00			
227	5	4.0000	1.0800	50.300	1.1950	1.0000
232	5	.95000	.0	2.0000	3000.0	155.00
237	2	.0	1.1050			
240	2	.45000	.0			
303	4	.60000E-02	.15000	.75000	1.4000	
309	1	.32000E-02				
314	1	.75000				
316	1	5.5000				
319	3	1.0450	1.2500	1.3000		
323	1	2.8600				
326	2	1.2500	1.5400			
328	2	.15440E+07	6.2830			
330	1	6.0000				
331	5	.0	.20000	.40000	.60000	.80000
336	1	1.0000				
339	5	.59000E-02	.60000E-02	.66000E-02	.80000E-02	.95000E-02
344	1	.11600E-01				
347	5	3.0000	3.0000	.0	.50000	1.0000
354	3	.0	.50000	1.0000		

361	3	1.0000	1.0000	1.0000		
368	3	1.0000	1.0000	1.0000		
375	3	1.0000	1.0000	1.0000		
2602	3	3000.0	600.00	5000.0		
2605	3	.0	.0	.0		
2608	5	.0	.0	.0	.0	.0
2613	5	26.000	18.000	42.000	.0	.0
2618	4	100.00	.0	.0	.0	
2622	5	125.00	3.0000	.40000E-01	.80000	.0
2627	5	1.0000	.0	2.0600	.0	.0
2632	5	.0	[illegible]	.0	.0	.0
2637	5	44.000	1.0000	61.000	1.0000	1.2500
2642	5	.0	.0	.0	.0	250.00
2647	5	4.0000	.0	.0	.0	.19000
2652	2	200.00	.0			
2654	5	1.0000	1.0000	1.0000	1.0000	1.0000
2659	5	1.0000	1.0000	1.0000	1.0000	1.0000
2664	5	1.0000	1.0000	1.0000	1.0000	1.0000
2669	5	1.0000	1.0000	1.0000	1.0000	1.0000
401	1	.0				
411	1	.33300E-01				
421	1	.0				
431	1	.0				
441	1	1.1050				
461	2	1.0000	1.0000			
481	2	.0	.0			
501	2	.0	.0			
511	2	.0	.0			
521	2	1.0000	1.0000			
531	2	.10000E-01	.10000E-01			
541	2	1.1650	1.1050			
551	2	.10000	.10000			
571	2	1.0000	4.0000			
582	1	120.00				
591	2	.0	.0			
601	2	.40000	.50000			
611	2	.0	.0			
621	2	530.00	500.00			
631	2	2.0000	2.0000			
641	2	5000.0	3000.0			
651	2	1.1050	1.1050			
661	2	.0	.0			
681	2	2.0000	2.0000			
701	2	.0	.0			
721	2	1.0000	4.0000			
732	1	25.000				
741	2	.0	.0			
751	2	.40000	.45000			
761	2	.0	.0			
771	2	20.000	20.000			
781	2	2.0000	2.0000			
791	2	80.000	100.00			
801	2	1.1050	1.1050			
811	2	.0	.0			
831	2	.0	.0			
1031	1	.0				
1041	1	.40000				
1051	1	.0				
1061	1	.50000E-01				
1071	1	1.1650				

```
 1081        1         .50000
 1101        1         .0
 1131        1         .0
 1181        2         1000.0          .0
WG = 0.300000E+05  WFA = 0.0           WFR = 0.0
WG = 0.300000E+05  WFA = 0.582602E+04  WFR = 0.397485E+04
WG = 0.273555E+05  WFA = 0.454982E+04  WFR = 0.365001E+04
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HESCOMP
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

TANDEM ROTOR WINGED HELICOPTER

SIZE DATA   THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 24854. LB

FUSELAGE

LF	LENGTH	47.8 FT.
LC	CABIN LENGTH	35.0 FT.
DELTAX1	FWD. ROTOR LOCATION	9.0 FT.
DELTAX2	AFT ROTOR LOCATION	4.5 FT.
WF	WIDTH	6.5 FT.
G/S	ROTOR GAP/STAGGER RATIO	0.160
(O/L/D)	ROTOR OVERLAP/DIAMETER RATIO	0.220
SF	WETTED AREA	936.4 SQ. FT.

WING

AR	ASPECT RATIO	6.00
SW	AREA	134.4 SQ. FT.
BW	SPAN	28.4 FT.
CBARW	MEAN CHORD	4.7 FT.
LAMBDA C/4	QUARTER CHORD SWEEP	0.0 DEG.
LAMBDA	TAPER RATIO	0.500
(T/C)R	ROOT THICKNESS/CHORD	0.200
(T/C)T	TIP THICKNESS/CHORD	0.120
WG/SW	WING LOADING	185.0 LBS/SQ. FT.
GRW	ROTOR/WING GAP	3.0 FT.
CF/C	FLAP CHORD/MEAN CHORD RATIO	1.000

FORWARD ROTOR PYLON

AR	ASPECT RATIO	0.400
SFP	WETTED AREA	50.0 SQ. FT.
FAFP	FRONTAL AREA	8.3 SQ. FT.
HP1	HEIGHT	3.6 FT.
CBARFP	MEAN CHORD	7.5 FT.
LAMBDA FP	TAPER RATIO	0.700
(T/C)R	ROOT THICKNESS/CHORD	0.450
(T/C)T	TIP THICKNESS/CHORD	0.256

AFT ROTOR PYLON

AR	ASPECT RATIO	0.700
SAP	WETTED AREA	234.3 SQ. FT.
HP2	HEIGHT	8.5 FT.
CBARAP	MEAN CHORD	12.1 FT.
LAMBDA AP	TAPER RATIO	0.750

(T/C)R	ROOT THICKNESS/CHORD	0.500
(T/C)T	TIP THICKNESS/CHORD	0.300

PRIMARY ENGINE NACELLE

LN	LENGTH	5.2 FT.
DN	MEAN DIAMETER	1. FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	94.1 SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION) - NO PROPELLER USED

MAIN ROTOR

DMR	DIAMETER	44.5 FT.
SIGMR	SOLIDITY	0.122
WG/A	DISC LOADING	8.0 LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.095
NR	NO. OF ROTORS	2.
NO. BLADES	NO. OF BLADES/ROTOR	4.
THETA	BLADE TWIST	-9.000 DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.200
VTIP	TIP SPEED	700. FT./SEC.

SAMPLE CASE NO. 2   RUN 1

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   6-91

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W E I G H T S   D A T A     IN LBS

            MLF             MANEUVER LOAD FACTOR                         3.000
            GLF             GUST LOAD FACTOR                             1.438
            ULF             ULTIMATE LOAD FACTOR                         4.500

     PROPULSION GROUP
            WPRG            TOTAL MAIN ROTOR GROUP                        2946.
        K12 WPRB                 MAIN ROTOR BLADE (PER ROTOR)                 599.
        K13 WPH                  MAIN ROTOR HUB (PER ROTOR)                   579.
            WBF                  BLADE FOLDING(PER ROTOR)                     295.
        K15 WAR             AUXILIARY PROPULSION ROTOR GROUP              0.
            WDS             DRIVE SYSTEM                                  2271.
        K16 WPDS                 MAIN ROTOR DRIVE SYSTEM                      2271.
        K20 WTRDS                TAIL ROTOR DRIVE SYSTEM                      0.
        K17 WADS                 AUXILIARY PROPULSION DRIVE SYSTEM            0.
        K18 WEP             PRIMARY ENGINES                               1074.
        K19 WEA             AUXILARY ENGINES                              0.
            WPEI            PRIMARY ENGINE INSTALLATION                   200.
            WAEI            AUXILIARY ENGINE INSTALLATION                 0.
            WFS             FUEL SYSTEM                                   635.
      DELTA WP              PROPULSION GROUP WEIGHT INCREMENT             0.
            WP         TOTAL PROPULSION GROUP WEIGHT                                 7126.

     STRUCTURES GROUP
        K8  WW              WING                                          277.
            WTG             TAIL GROUP                                    0.
        K9  WHT                  HOR. TAIL                                    0.
        K14 WTR                  TAIL ROTOR                                   0.
        K6  WB              FUSELAGE                                      3251.
        K7  WLG             LANDING GEAR                                  994.
            WNG                  NOSE GEAR                                    199.
            WMG                  MAIN GEAR                                    795.
            WTES            TOTAL ENGINE SECTION                          120.
            WPES                 PRIMARY ENGINE SECTION                       120.
            WAES                 AUXILIARY ENGINE SECTION                     0.
      DELTA WST             STRUCTURE WEIGHT INCREMENT                    0.
            WST        TOTAL STRUCTURE WEIGHT                                        4642.

     FLIGHT CONTROLS GROUP
            WPFC            PRIMARY FLIGHT CONTROLS                       1145.
            WCC                  COCKPIT CONTROLS                             97.
        K1  WRC                  MAIN ROTOR CONTROLS                          351.
        K2  WSC                  MAIN ROTOR SYSTEMS CONTROLS                  597.
        K3  WFW                  FIXED WING CONTROLS                          0.
            WTM                  TILT MECHANISM                               0.
            WSAS                 SAS                                          100.
            WAFC            AUXILIARY FLIGHT CONTROLS                     0.
        K4  WRCA                 AUX. PROPULSION ROTOR CONTROLS               0.
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K5  WSCA          AUX. PROPULSION ROTOR SYS. CONTROLS         0.
       WMC           MISCELLANEOUS CONTROLS                     0.
DELTA WFC         CONTROL WEIGHT INCREMENT               0.
          WFC     TOTAL CONTROL WEIGHT                                   1145.

WFE               WEIGHT OF FIXED EQUIPMENT                              3066.

WE                WEIGHT EMPTY                                          15914.

WFUL              FIXED USEFUL LOAD                                       600.

OWE               OPERATING WEIGHT EMPTY                                16514.

WPL               PAYLOAD                                                5000.

(WF)A             FUEL                                                   3341.

WG                GROSS WEIGHT                                          24854.
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   6-91

R O T O R   D A T A

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ROTOR CYCLE NO.    3.0000

MAIN ROTOR SOLIDITY SIZED BY MANUEVER CONDITIONS
H =     4060.9 FT. , TEMP =      44.7 DEG. , V =      160.0 KT.
100.0 PERCENT HOVER RPM
ROTOR MANUEVER G'S =  1.500 , CT/SIGMA = 0.095
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                    H E S C O M P
    HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    6-91


P R O P U L S I O N   D A T A
     PRIMARY PROPULSION CYCLE NO.    1.761
          TURBOSHAFT ENGINE

           4.  ENGINES

        BHP.P          MAX. STANDARD S.L. STATIC H.P.          6756.     H.P.

        ENGINE SIZED FOR TAKEOFF AT T/W =1.08
         95.0 PERCENT MILITARY POWER SETTING.
        H = 4000. FT. TEMPERATURE = 95.04 DEG.F..
         1.000 ENGINES INOPERATIVE, AND     0.0  FT/MIN VERTICAL RATE OF CLIMB.

           MAIN ROTOR DRIVE SYSTEM RATING          3671.     H.P.

     XMSN SIZED AT 100. PERCENT OF MAIN ROTOR HOVER POWER REQUIRED
     AT H = 4000. FT. TEMP = 95.04 DEG.F.. 100.0 PERCENT HOVER RPM
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HESCOMP
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

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AERODYNAMICS DATA
          FE          TOTAL EFFECTIVE FLATPLATE AREA            23.662    SQFT
          SWET        TOTAL WETTED AREA                          1529.    SQFT
          CBARF       MEAN SKIN FRICTION COEFF.               0.015480
      DRAG BREAKDOWN                  IN  SQFT
          FEW         WING FE                                       1.285
          FEF         FUSELAGE FE                                   2.479
          FEFP        FORWARD(MAIN) ROTOR PYLON FE                  1.551
          FEAP        AFT ROTOR PYLON FE                            1.330
          FEMRH       MAIN ROTOR HUB(S) FE                         12.067
          FETRH       TAIL ROTOR HUB FE                             0.0
          FEVT        VERTICAL TAIL FE                              0.0
          FEHT        HORIZONTAL TAIL FE                            0.0
          FEN         PRIMARY ENGINE NACELLE FE                     0.892
          FENI        AUX. INDEPENDENT CRUISE ENG. NAC. FE          0.0
          FENS        AUX. INDPENDENT CRUISE ENG. STRUT FE          0.0
          DELTA FE    INCREMENTAL FE                                4.058
AERODYNAMIC COEFF.
          A5                                                  22.37697
          A6                                                   1.62078
          A7                                                   0.07374
          A8                                                   0.00010
          A9                                                   0.0
          E       WING LIFT EFFICIENCY FACTOR                0.75000
          EVT     VERTICAL TAIL LIFT EFFICIENCY FACTOR       0.0
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM 6-91

MISSION PERFORMANCE DATA

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRESS. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	AUX. TURB. TEMP. (R)	AUX. ENG. CODE	AUX. ENG. PEHF	AUX. ENG. FUEL FLOW (LBS/HR)	TEMP. DEG. (F)
0.0	0.0	0.0	24854.	0.	0.0	950.0	T	0.0	461.	----	----	----		59.0
0.033	0.0	15.4	24839.	0.	0.0	950.0	T	0.0	461.	----	----	----		59.0

TAKEOFF, HOVER, OR LAND AT T/W = 1.080 FOR 0.100 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	BHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CDO
0.033	0.0	15.4	24839.	0.	0.0	1574.7	P	0.486	1772.	1.080	0.673	3282.	0.0074	0.061
700.0	3087.	----	----	0.	1772.		A		59.0	0.0	0.707	0.00011	0.00055	0.0072
0.043	0.0	33.1	24821.	0.	0.0	1574.3	P	0.485	1771.	1.080	0.673	3279.	0.0074	0.061
700.0	3084.	----	----	0.	1771.		A		59.0	0.0	0.707	0.00011	0.00056	0.0072
0.053	0.0	50.8	24803.	0.	0.0	1573.9	P	0.485	1769.	1.080	0.673	3276.	0.0074	0.061
700.0	3080.	----	----	0.	1769.		A		59.0	0.0	0.707	0.00011	0.00056	0.0072
0.063	0.0	68.5	24786.	0.	0.0	1573.5	P	0.484	1768.	1.080	0.673	3272.	0.0074	0.061
700.0	3077.	----	----	0.	1768.		A		59.0	0.0	0.707	0.00011	0.00056	0.0072
0.073	0.0	86.2	24768.	0.	0.0	1573.1	P	0.484	1767.	1.080	0.673	3269.	0.0074	0.061
700.0	3074.	----	----	0.	1767.		A		59.0	0.0	0.707	0.00011	0.00056	0.0072
0.083	0.0	103.8	24750.	0.	0.0	1572.7	P	0.483	1766.	1.080	0.673	3266.	0.0074	0.060
700.0	3071.	----	----	0.	1766.		A		59.0	0.0	0.707	0.00011	0.00056	0.0072
0.093	0.0	121.5	24733.	0.	0.0	1572.3	P	0.483	1765.	1.080	0.673	3262.	0.0074	0.060
700.0	3068.	----	----	0.	1765.		A		59.0	0.0	0.707	0.00011	0.00056	0.0072
0.103	0.0	139.1	24715.	0.	0.0	1571.9	P	0.482	1764.	1.080	0.673	3259.	0.0074	0.060
700.0	3064.	----	----	0.	1764.		A		59.0	0.0	0.707	0.00011	0.00056	0.0072
0.113	0.0	156.8	24697.	0.	0.0	1571.6	P	0.482	1763.	1.080	0.673	3256.	0.0074	0.060
700.0	3061.	----	----	0.	1763.		A		59.0	0.0	0.707	0.00011	0.00055	0.0072

0.123	0.0	174.4	24680.	0.	0.0	1571.2	P	0.481	1762.	1.080	0.673	3253.	0.0074	0.060
700.0	3056.	----	----	0.	1762.		A		59.0	0.0	0.707	0.00011	0.00055	0.0072
0.133	0.0	192.0	24662.	0.	0.0	1570.8	P	0.481	1761.	1.080	0.673	3249.	0.0074	0.060
700.0	3055.	----	----	0.	1761.		A		59.0	0.0	0.707	0.00011	0.00055	0.0072
0.133	0.0	192.0	24662.	0.	0.0	1570.8	P	0.481	1761.	1.080	0.673	3249.	0.0074	0.060
700.0	3055.	----	----	0.	1761.		A		59.0	0.0	0.707	0.00011	0.00055	0.0072

CLIMB TO 5000. FT. WITH MAXIMUM R/C AT NORMAL ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	ML	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	BHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. BHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCOS	DELCOM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN	
0.133	0.0	192.0	24662.	0.	84.5	1856.0	T	0.835	84.5	0.206	0.053	-2.1	6.0	2853.	913.
700.0	1669.	----	----	----	1311.	----	----	0.0	----	----	----	----		----	
0.000157	0.000186	0.000651	0.000012	0.00861	0.0	0.00023	0.000240	A	----	----	----	0.466	0.007	0.946	
0.142	0.78	204.6	24650.	500.	85.5	1856.0	T	0.837	84.9	0.209	0.054	-2.1	5.7	2824.	877.
700.0	1672.	----	----	----	1295.	----	----	0.0	----	----	----	----		----	
0.000159	0.000189	0.000652	0.000012	0.00865	0.0	0.00027	0.000245	A	----	----	----	0.406	0.007	0.945	
0.152	1.60	216.3	24638.	1000.	85.5	1856.0	T	0.838	84.3	0.209	0.054	-2.1	5.5	2794.	841.
700.0	1674.	----	----	----	1279.	----	----	0.0	----	----	----	----		----	
0.000159	0.000195	0.000653	0.000012	0.00867	0.00000	0.00030	0.000246	A	----	----	----	0.400	0.007	0.946	
0.162	2.46	229.0	24625.	1500.	85.5	1856.0	T	0.840	83.6	0.209	0.055	-2.1	5.2	2763.	805.
700.0	1676.	----	----	----	1264.	----	----	0.0	----	----	----	----		----	
0.000159	0.000201	0.000653	0.000013	0.00870	0.00000	0.00032	0.000247	A	----	----	----	0.400	0.007	0.947	
0.172	3.36	242.6	24612.	2000.	86.5	1856.0	T	0.841	84.0	0.211	0.056	-2.1	4.9	2733.	768.
700.0	1681.	----	----	----	1248.	----	----	0.0	----	----	----	----		----	
0.000161	0.000204	0.000655	0.000013	0.00875	0.00000	0.00037	0.000252	A	----	----	----	0.400	0.007	0.947	
0.183	4.31	255.6	24599.	2500.	86.5	1856.0	T	0.843	83.4	0.211	0.057	-2.1	4.7	2703.	731.
700.0	1684.	----	----	----	1233.	----	----	0.0	----	----	----	----		----	
0.000161	0.000211	0.000655	0.000013	0.00878	0.00000	0.00040	0.000253	A	----	----	----	0.400	0.007	0.947	
0.194	5.31	269.6	24585.	3000.	87.5	1856.0	T	0.844	83.7	0.213	0.059	-2.1	4.4	2673.	693.
700.0	1689.	----	----	----	1217.	----	----	0.0	----	----	----	----		----	
0.000163	0.000214	0.000657	0.000014	0.00884	0.00000	0.00046	0.000258	A	----	----	----	0.400	0.007	0.947	
0.206	6.37	284.3	24570.	3500.	87.5	1856.0	T	0.846	83.1	0.213	0.059	-2.1	4.2	2643.	655.
700.0	1693.	----	----	----	1202.	----	----	0.0	----	----	----	----		----	
0.000164	0.000221	0.000657	0.000014	0.00887	0.00000	0.00050	0.000259	A	----	----	----	0.400	0.007	0.948	

0.219	7.50	299.5	24555.	4900.	87.5	1856.0	T	0.847	82.5	0.213	0.859	-2.1	3.9	2612.	617.
700.0	1897.	----	----	----	1187.	----	----	0.0	----	----	----	----		----	
0.000165	0.000228	0.000057	0.000015	0.00891	0.00000	0.00053	0.000260	A	----	----	----	0.400	0.007	0.948	
0.233	8.70	315.6	24539.	4500.	88.5	1856.0	T	0.849	82.8	0.216	0.860	-2.1	3.6	2583.	578.
700.0	1903.	----	----	----	1172.	----	----	0.0	----	----	----	----		----	
0.000167	0.000232	0.000059	0.000015	0.00899	0.00000	0.00061	0.000266	A	----	----	----	0.400	0.007	0.948	
0.247	9.99	332.5	24522.	5000.	88.5	1856.0	T	0.850	82.2	0.216	0.861	-2.0	3.4	2553.	538.
700.0	1909.	----	----	----	1156.	----	----	0.0	----	----	----	----		----	
0.000167	0.000239	0.000059	0.000016	0.00903	0.00000	0.00065	0.000267	A	----	----	----	0.409	0.007	0.949	

CRUISE AT NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	BHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPMUD	CDO	DELCDS	DELCOM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
0.247	9.99	332.5	24522.	5000.	182.7	1856.0	T	0.851	169.6	0.440	0.051	-7.5	.07753	5323.
700.0	5066.	----	----	----	2356.	----	----	0.0	----	----	----	----		----
0.000685	0.000081	0.000559	0.000032	0.02087	0.00074	0.01172	0.000856	A	----	----	----	0.400	0.007	0.786
0.357	29.99	590.5	24264.	5000.	183.5	1856.0	T	0.851	170.4	0.443	0.050	-8.1	.07789	5374.
700.0	5116.	----	----	----	2357.	----	----	0.0	----	----	----	----		----
0.000616	0.000079	0.000569	0.000031	0.02096	0.00071	0.01184	0.000863	A	----	----	----	0.400	0.007	0.782
0.466	49.99	847.2	24007.	5000.	183.8	1856.0	T	0.851	170.6	0.443	0.049	-8.2	.07808	5373.
700.0	5114.	----	----	----	2357.	----	----	0.0	----	----	----	----		----
0.000610	0.000076	0.000572	0.000031	0.02091	0.00066	0.01183	0.000864	A	----	----	----	0.400	0.007	0.779
0.574	69.99	1103.6	23751.	5000.	184.1	1856.0	T	0.851	170.9	0.444	0.048	-8.3	.07812	5371.
700.0	5113.	----	----	----	2357.	----	----	0.0	----	----	----	----		----
0.000609	0.000074	0.000576	0.000030	0.02085	0.00062	0.01181	0.000866	A	----	----	----	0.400	0.007	0.776
0.629	80.00	1231.8	23622.	5000.	184.3	1856.0	T	0.851	171.0	0.444	0.048	-8.4	.07816	5376.
700.0	5112.	----	----	----	2357.	----	----	0.0	----	----	----	----		----
0.000609	0.000073	0.000577	0.000030	0.02082	0.00060	0.01180	0.000867	A	----	----	----	0.400	0.007	0.774

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.629	80.00	1231.8	23622.	5000.
0.629	80.00	1231.8	23622.	1000.

LOITER FOR 0.500 HRS. FOR RESERVE FUEL

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	BHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCOS	DELCOM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
0.629	80.00	1231.0	23622.	1000.	85.0	1415.9	P	0.292	83.7	0.205	0.052	-2.1	1293.	1946.
700.0	1798.	----	----	----	1293.	----	----	0.0	----	----	----	----		----
0.000157	0.000182	0.000050	0.000011	0.00863	0.0	0.00025	0.000237	A	----	----	----	0.400	0.007	0.946
0.679	80.00	1296.4	23558.	1000.	85.0	1415.3	P	0.291	83.7	0.205	0.052	-2.1	1291.	1940.
700.0	1785.	----	----	----	1291.	----	----	0.0	----	----	----	----		----
0.000157	0.000181	0.000050	0.000011	0.00863	0.0	0.00025	0.000237	A	----	----	----	0.400	0.007	0.946
0.729	80.00	1361.0	23493.	1000.	84.0	1414.6	P	0.290	82.7	0.202	0.052	-2.1	1290.	1934.
700.0	1779.	----	----	----	1290.	----	----	0.0	----	----	----	----		----
0.000156	0.000183	0.000048	0.000011	0.00861	0.0	0.00023	0.000232	A	----	----	----	0.400	0.007	0.947
0.779	80.00	1425.5	23429.	1000.	84.0	1414.0	P	0.290	82.7	0.202	0.052	-2.1	1288.	1929.
700.0	1774.	----	----	----	1288.	----	----	0.0	----	----	----	----		----
0.000156	0.000182	0.000048	0.000011	0.00861	0.0	0.00023	0.000232	A	----	----	----	0.400	0.007	0.947
0.829	80.00	1489.9	23364.	1000.	84.0	1413.4	P	0.289	82.7	0.202	0.052	-2.1	1286.	1924.
700.0	1769.	----	----	----	1286.	----	----	0.0	----	----	----	----		----
0.000156	0.000181	0.000048	0.000011	0.00860	0.0	0.00023	0.000232	A	----	----	----	0.400	0.007	0.947
0.879	80.00	1554.2	23300.	1000.	84.0	1412.8	P	0.288	82.7	0.202	0.052	-2.1	1285.	1918.
700.0	1764.	----	----	----	1285.	----	----	0.0	----	----	----	----		----
0.000156	0.000180	0.000048	0.000011	0.00860	0.0	0.00022	0.000232	A	----	----	----	0.400	0.007	0.946
0.929	80.00	1618.4	23236.	1000.	84.0	1412.2	P	0.287	82.7	0.202	0.051	-2.1	1283.	1913.
700.0	1759.	----	----	----	1283.	----	----	0.0	----	----	----	----		----
0.000156	0.000179	0.000048	0.000010	0.00860	0.0	0.00022	0.000232	A	----	----	----	0.400	0.007	0.946
0.979	80.00	1682.6	23172.	1000.	84.0	1411.6	P	0.286	82.7	0.202	0.051	-2.1	1281.	1908.
700.0	1754.	----	----	----	1281.	----	----	0.0	----	----	----	----		----
0.000156	0.000178	0.000048	0.000010	0.00860	0.0	0.00022	0.000231	A	----	----	----	0.400	0.007	0.946
1.029	80.00	1746.7	23108.	1000.	84.0	1410.9	P	0.286	82.7	0.202	0.051	-2.1	1280.	1903.
700.0	1749.	----	----	----	1280.	----	----	0.0	----	----	----	----		----
0.000156	0.000177	0.000048	0.000010	0.00860	0.0	0.00022	0.000231	A	----	----	----	0.400	0.007	0.946
1.079	80.00	1810.7	23044.	1000.	84.0	1410.3	P	0.285	82.7	0.202	0.051	-2.1	1278.	1898.
700.0	1744.	----	----	----	1278.	----	----	0.0	----	----	----	----		----
0.000156	0.000176	0.000048	0.000010	0.00860	0.0	0.00022	0.000231	A	----	----	----	0.400	0.007	0.946
1.129	80.00	1874.6	22980.	1000.	84.0	1409.7	P	0.284	82.7	0.202	0.051	-2.1	1276.	1892.
700.0	1739.	----	----	----	1276.	----	----	0.0	----	----	----	----		----
0.000156	0.000175	0.000048	0.000010	0.00860	0.0	0.00022	0.000231	A	----	----	----	0.400	0.007	0.946

CLIMB TO 3000. FT. WITH CONSTANT TAS AT NORMAL ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	BHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN	
0.629	60.00	1874.6	23622.	1000.	120.0	1856.0	T	0.838	118.3	0.289	0.048	-4.2	2.8	2825.	589.
700.0	2147.	----	----	----	1287.	----	----	0.0	----	----	----	----		----	
0.000208	0.000109	0.000136	0.000927	0.00984	0.00000	0.00143	0.000430	A	----	----	----	0.500	0.007	0.865	
0.643	61.70	1892.8	23604.	1500.	120.0	1856.0	T	0.840	117.4	0.289	0.048	-4.2	2.6	2794.	559.
700.0	2143.	----	----	----	1272.	----	----	0.0	----	----	----	----		----	
0.000210	0.000113	0.000136	0.000928	0.00992	0.00016	0.00151	0.000431	A	----	----	----	0.500	0.007	0.867	
0.658	83.49	1911.7	23585.	2000.	120.0	1856.0	T	0.842	116.5	0.289	0.049	-4.1	2.5	2764.	529.
700.0	2139.	----	----	----	1256.	----	----	0.0	----	----	----	----		----	
0.000212	0.000116	0.000136	0.000928	0.01000	0.00010	0.00160	0.000432	A	----	----	----	0.500	0.007	0.869	
0.674	85.38	1931.5	23565.	2500.	120.0	1856.0	T	0.843	115.7	0.289	0.050	-4.1	2.3	2733.	499.
700.0	2135.	----	----	----	1241.	----	----	0.0	----	----	----	----		----	
0.000214	0.000120	0.000137	0.000928	0.01009	0.00011	0.00168	0.000434	A	----	----	----	0.500	0.007	0.871	
0.690	87.36	1952.2	23545.	3000.	120.0	1856.0	T	0.844	114.8	0.289	0.051	-4.0	2.2	2702.	468.
700.0	2132.	----	----	----	1225.	----	----	0.0	----	----	----	----		----	
0.000216	0.000124	0.000137	0.000929	0.01018	0.00001	0.00177	0.000435	A	----	----	----	0.500	0.007	0.873	

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 25.0 KNOTS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SFLC. RANGE (NMPP)	BHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
0.690	67.38	1952.2	23545.	3000.	156.6	1605.5	P	0.543	149.8	0.378	0.047	-6.6	.07489	3532.
700.0	3329.	----	----	----	1756.	----	----	0.0	----	----	----	----		----

0.000353	0.000081	0.000314	0.000042	0.01394	0.00010	0.00544	0.000659	A	----	----	----	0.450	0.007	0.805
0.842	107.30	2219.3	23278.	3000.	156.6	1602.9	P	0.540	149.8	0.378	0.046	-6.7	.07528	3511.
700.0	3309.	----	----	----	1751.	----	----	0.0	----	----	----	----		----
0.000352	0.000079	0.000313	0.000041	0.01389	0.00009	0.00539	0.000658	A	----	----	----	0.450	0.007	0.802
0.994	127.30	2485.2	23012.	3000.	156.6	1600.4	P	0.537	149.8	0.378	0.046	-6.7	.07551	3491.
700.0	3289.	----	----	----	1744.	----	----	0.0	----	----	----	----		----
0.000350	0.000077	0.000313	0.000041	0.01383	0.00008	0.00534	0.000657	A	----	----	----	0.450	0.007	0.800
1.146	147.30	2750.1	22747.	3000.	156.6	1597.9	P	0.534	149.8	0.378	0.045	-6.8	.07581	3471.
700.0	3270.	----	----	----	1737.	----	----	0.0	----	----	----	----		----
0.000349	0.000075	0.000312	0.000040	0.01377	0.00007	0.00529	0.000656	A	----	----	----	0.450	0.007	0.798
1.298	167.30	3013.9	22483.	3000.	156.6	1595.4	P	0.531	149.8	0.378	0.044	-6.9	.07611	3451.
700.0	3250.	----	----	----	1730.	----	----	0.0	----	----	----	----		----
0.000348	0.000072	0.000312	0.000039	0.01372	0.00006	0.00525	0.000655	A	----	----	----	0.450	0.007	0.795
1.394	166.00	3179.7	22317.	3000.	156.6	1593.9	P	0.529	149.8	0.378	0.044	-7.0	.07629	3439.
700.0	3238.	----	----	----	1726.	----	----	0.0	----	----	----	----		----
0.000347	0.000071	0.000312	0.000039	0.01368	0.00006	0.00522	0.000655	A	----	----	----	0.450	0.007	0.794

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.394	180.00	3179.7	22317.	3000.
1.394	180.00	3179.7	22317.	0.

TAKEOFF, HOVER, OR LAND AT T/W = 1.080 FOR 0.100 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	BHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RMP	T.ROTOR VTIP (FPS)	T.ROTOR RMP	VRC RMP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CDO
1.394	180.00	3179.7	22317.	0.	0.0	1523.2	P	0.420	1625.	1.080	0.666	2840.	0.0067	0.055
700.0	2658.	----	----	0.	1625.	----	A		59.0	0.0	0.698	0.00011	0.00047	0.0072
1.404	180.00	3195.9	22301.	0.	0.0	1522.9	P	0.420	1624.	1.080	0.666	2838.	0.0067	0.055
700.0	2656.	----	----	0.	1624.	----	A		59.0	0.0	0.698	0.00011	0.00047	0.0072
1.414	180.00	3212.2	22285.	0.	0.0	1522.6	P	0.420	1623.	1.080	0.666	2835.	0.0067	0.054
700.0	2653.	----	----	0.	1623.	----	A		59.0	0.0	0.698	0.00011	0.00047	0.0072
1.424	180.00	3228.4	22269.	0.	0.0	1522.3	P	0.419	1622.	1.080	0.666	2832.	0.0066	0.054
700.0	2650.	----	----	0.	1622.	----	A		59.0	0.0	0.698	0.00011	0.00047	0.0072
1.434	180.00	3244.6	22252.	0.	0.0	1522.0	P	0.419	1621.	1.080	0.666	2830.	0.0066	0.054
700.0	2648.	----	----	0.	1621.	----	A		59.0	0.0	0.698	0.00011	0.00046	0.0072
1.444	180.00	3260.8	22236.	0.	0.0	1521.7	P	0.418	1620.	1.080	0.665	2827.	0.0066	0.054
700.0	2645.	----	----	0.	1620.	----	A		59.0	0.0	0.697	0.00011	0.00046	0.0072

1.454	180.00	3277.0	22220.	0.	0.0	1521.4	P	0.418	1620.	1.080	0.665	2625.	0.0066	0.054
700.0	2643.	----	----	0.	1620.	----	A		59.0	0.0	0.697	0.00011	0.00046	0.0072
1.464	180.00	3293.2	22204.	0.	0.0	1521.1	P	0.418	1619.	1.080	0.665	2622.	0.0066	0.054
700.0	2640.	----	----	0.	1619.	----	A		59.0	0.0	0.697	0.00011	0.00046	0.0072
1.474	180.00	3309.4	22188.	0.	0.0	1520.7	P	0.417	1618.	1.080	0.665	2819.	0.0066	0.054
700.0	2638.	----	----	0.	1618.	----	A		59.0	0.0	0.697	0.00011	0.00046	0.0072
1.484	180.00	3325.6	22171.	0.	0.0	1520.4	P	0.417	1617.	1.080	0.665	2817.	0.0066	0.054
700.0	2635.	----	----	0.	1617.	----	A		59.0	0.0	0.697	0.00011	0.00046	0.0072
1.494	180.00	3341.8	22155.	0.	0.0	1520.1	P	0.417	1616.	1.080	0.665	2814.	0.0066	0.054
700.0	2633.	----	----	0.	1616.	----	A		59.0	0.0	0.697	0.00011	0.00046	0.0072
1.494	180.00	3341.8	22155.	0.	0.0	1520.1	P	0.417	1616.	1.080	0.665	2814.	0.0066	0.054
700.0	2633.	----	----	0.	1616.	----	A		59.0	0.0	0.697	0.00011	0.00046	0.0072

MISSION FUEL REQUIRED = 2698.99
RESERVE FUEL REQUIRED = 642.79
TOTAL FUEL REQUIRED = 3341.77

****

END OF SUCCESSFUL CASE

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SAMPLE CASE NO. 2   RUN 2                                                    PAGE   1

                                      H E S C O M P
                  HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    6-91

              THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

         LOC.  CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
         NUM   STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
         VAL   EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
         VAL1          VALUE               CORRESPONDING TO LOC.+0001
         VAL2          VALUE               CORRESPONDING TO LOC.+0002
              ETC.

           LOC.        NUM        VAL           VAL1           VAL2           VAL3           VAL4

              NOTE : IN USING AUXILIARY ENGINES 3.AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED
              BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

           2         1         .1
         WG = 0.300009E+05  WFA = 0.334065E+04  WFP = 0.334177E+04
         WG = 0.300003E+05  WFA = 0.582652E+04  WFR = 0.397489E+04
         WG = 0.273555E+05  WFA = 0.454982E+04  WFR = 0.365001E+04
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM 6-91

TANDEM ROTOR WINGED HELICOPTER

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 24854. LB

FUSELAGE

LF	LENGTH	47.8 FT.
LC	CABIN LENGTH	35.0 FT.
DELTAX1	FWD. ROTOR LOCATION	9.8 FT.
DELTAX2	AFT ROTOR LOCATION	4.5 FT.
WF	WIDTH	6.5 FT.
G/S	ROTOR GAP/STAGGER RATIO	0.160
(O/L/D)	ROTOR OVERLAP/DIAMETER RATIO	0.220
SF	WETTED AREA	936.4 SQ. FT.

WING

AR	ASPECT RATIO	6.00
SW	AREA	134.4 SQ. FT.
BW	SPAN	26.4 FT.
CBARW	MEAN CHORD	4.7 FT.
LAMBDA C/4	QUARTER CHORD SWEEP	0.0 DEG.
LAMBDA	TAPER RATIO	0.500
(T/C)R	ROOT THICKNESS/CHORD	0.290
(T/C)T	TIP THICKNESS/CHORD	0.120
WG/SW	WING LOADING	185.0 LBS/SQ. FT.
GRW	ROTOR/WING GAP	3.0 FT.
CF/C	FLAP CHORD/MEAN CHORD RATIO	1.000

FORWARD ROTOR PYLON

AR	ASPECT RATIO	0.400
SFP	WETTED AREA	50.0 SQ. FT.
FAFP	FRONTAL AREA	8.3 SQ. FT.
HP1	HEIGHT	3.0 FT.
CBARFP	MEAN CHORD	7.5 FT.
LAMBDA FP	TAPER RATIO	0.700
(T/C)R	ROOT THICKNESS/CHORD	0.450
(T/C)T	TIP THICKNESS/CHORD	0.250

AFT ROTOR PYLON

AR	ASPECT RATIO	0.700
SAP	WETTED AREA	234.3 SQ. FT.
HP2	HEIGHT	8.5 FT.
CBARAP	MEAN CHORD	12.1 FT.
LAMBDA AP	TAPER RATIO	0.759

(T/C)R	ROOT THICKNESS/CHORD	0.500
(T/C)T	TIP THICKNESS/CHORD	0.300

PRIMARY ENGINE NACELLE

LN	LENGTH	5.2 FT.
DN	MEAN DIAMETER	1. FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	94.1 SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION) - NO PROPELLER USED

MAIN ROTOR

DMR	DIAMETER	44.5 FT.
SIGMR	SOLIDITY	0.122
WG/A	DISC LOADING	8.0 LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.095
NR	NO. OF ROTORS	2.
NO. BLADES	NO. OF BLADES/ROTOR	4.
THETA	BLADE TWIST	-9.000 DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.200
VTIP	TIP SPEED	780. FT./SEC.

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W E I G H T S   D A T A    IN LBS

        MLF          MANEUVER LOAD FACTOR                      3.000
        GLF          GUST LOAD FACTOR                          1.438
        ULF          ULTIMATE LOAD FACTOR                      4.500

    PROPULSION GROUP
            WPRG     TOTAL MAIN ROTOR GROUP                     2946.
        K12 WPRE         MAIN ROTOR BLADE (PER ROTOR)                599.
        K13 WPH          MAIN ROTOR HUB (PER ROTOR)                  579.
            WBF          BLADE FOLDING(PER ROTOR)                    295.
        K15 WAR      AUXILIARY PROPULSION ROTOR GROUP              0.
            WDS      DRIVE SYSTEM                               2271.
        K16 WPDS         MAIN ROTOR DRIVE SYSTEM                    2271.
        K20 WTRDS        TAIL ROTOR DRIVE SYSTEM                       0.
        K17 WADS         AUXILIARY PROPULSION DRIVE SYSTEM             0.
        K18 WEP      PRIMARY ENGINES                            1074.
        K19 WEA      AUXILARY ENGINES                              0.
            WPEI     PRIMARY ENGINE INSTALLATION                 200.
            WAEI     AUXILIARY ENGINE INSTALLATION                 0.
            WFS      FUEL SYSTEM                                 635.
        DELTA WP     PROPULSION GROUP WEIGHT INCREMENT             0.
               WP  TOTAL PROPULSION GROUP WEIGHT                                   7126.

    STRUCTURES GROUP
        K8  WW       WING                                        277.
            WTG      TAIL GROUP                                    0.
        K9  WHT          HOR. TAIL                                     0.
        K14 WTR          TAIL ROTOR                                    0.
        K6  WB       FUSELAGE                                   3251.
        K7  WLG      LANDING GEAR                                994.
            WNG          NOSE GEAR                                   195.
            WMG          MAIN GEAR                                   795.
            WTES     TOTAL ENGINE SECTION                        120.
            WPES         PRIMARY ENGINE SECTION                      120.
            WAES         AUXILIARY ENGINE SECTION                      0.
        DELTA WST    STRUCTURE WEIGHT INCREMENT                    0.
              WST  TOTAL STRUCTURE WEIGHT                                          4642.

    FLIGHT CONTROLS GROUP
            WPFC     PRIMARY FLIGHT CONTROLS                    1145.
            WCC          COCKPIT CONTROLS                             97.
        K1  WRC          MAIN ROTOR CONTROLS                         351.
        K2  WSC          MAIN ROTOR SYSTEMS CONTROLS                 597.
        K3  WFW          FIXED WING CONTROLS                           0.
            WTM          TILT MECHANISM                                0.
            WSAS         SAS                                         100.
            WAFC     AUXILIARY FLIGHT CONTROLS                     0.
        K4  WRCA         AUX. PROPULSION ROTOR CONTROLS                0.
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KS WSCA	AUX. PROPULSION ROTOR SYS. CONTROLS	0.	
WMC	MISCELLANEOUS CONTROLS	0.	
DELTA WFC	CONTROL WEIGHT INCREMENT	0.	
WFC	TOTAL CONTROL WEIGHT		1145.
WFE	WEIGHT OF FIXED EQUIPMENT		3000.
WE	WEIGHT EMPTY		15914.
WFUL	FIXED USEFUL LOAD		600.
OWE	OPERATING WEIGHT EMPTY		16514.
WPL	PAYLOAD		5000.
(WF)A	FUEL		3341.
WG	GROSS WEIGHT		24854.

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        HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    6-91


  R O T O R   D A T A


        ROTOR CYCLE NO.     3.0000

        MAIN ROTOR SOLIDITY SIZED BY MANUEVER CONDITIONS
        H =      4000.0 FT. , TEMP =      44.7 DEG. , V =      160.0 KT.
        100.0 PERCENT HOVER RPM
        ROTOR MANUEVER G'S =  1.500 , CT/SIGMA = 0.095
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                         H E S C O M P
           HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    b-91


   P R O P U L S I O N   D A T A
          PRIMARY PROPULSION CYCLE NO.     1.761
                TURBOSHAFT ENGINE

                 4.  ENGINES

             BHP-P          MAX. STANDARD S.L. STATIC H.P.         6756.     H.P.

             ENGINE SIZED FOR TAKEOFF AT T/W =1.00
              95.0 PERCENT MILITARY POWER SETTING.
             H = 4000. FT, TEMPERATURE = 95.04 DEG.F.,
              1.000 ENGINES INOPERATIVE, AND     0.0  FT/MIN VERTICAL RATE OF CLIMB.


                MAIN ROTOR DRIVE SYSTEM RATING           3671.     H.P.

          XMSN SIZED AT 100. PERCENT OF MAIN ROTOR HOVER POWER REQUIRED
          AT H = 4000. FT, TEMP = 95.04 DEG.F., 100.0 PERCENT HOVER RPM
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                         H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    6-91

A E R O D Y N A M I C S   D A T A
             FE             TOTAL EFFECTIVE FLATPLATE AREA         23.662     SQFT
             SWET           TOTAL WETTED AREA                       1529.     SQFT
             CBARF          MEAN SKIN FRICTION COEFF.             0.015480
          D R A G   B R E A K D O W N          IN  SQFT
             FEW            WING FE                                         1.285
             FEF            FUSELAGE FE                                     2.479
             FEFP           FORWARD(MAIN) ROTOR PYLON FE                    1.551
             FEAP           AFT ROTOR PYLON FE                              1.330
             FEMRH          MAIN ROTOR HUB(S) FE                           12.067
             FETRH          TAIL ROTOR HUB FE                               0.0
             FEVT           VERTICAL TAIL FE                                0.0
             FEHT           HORIZONTAL TAIL FE                              0.0
             FEN            PRIMARY ENGINE NACELLE FE                       0.892
             FENI           AUX. INDEPENDENT CRUISE ENG. NAC. FE            0.0
             FENS           AUX. INDPENDENT CRUISE ENG. STRUT FE            0.0
             DELTA FE       INCREMENTAL FE                                  4.058
A E R O D Y N A M I C   C O E F F .
             A5                                                        22.37697
             A6                                                         1.62078
             A7                                                         0.07074
             A8                                                         0.00010
             A9                                                         0.0
             E        WING LIFT EFFICIENCY FACTOR                 0.75000
             EVT      VERTICAL TAIL LIFT EFFICIENCY FACTOR        0.0
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   8-91

MISSION PERFORMANCE DATA

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRESS. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	TOTAL FUEL FLOW (LBS/HR)	AUX. TURB. TEMP. (R)	AUX. ENG. CODE	AUX. ENG. PEMF	AUX. ENG. FUEL FLOW (LBS/HR)	TEMP. DEG. (F)
0.0	0.0	0.0	24854.	0.	0.0	950.0	T	0.0	461.	----	----	----		59.0
0.033	0.0	15.4	24839.	0.	0.0	950.0	T	0.0	461.	----	----	----		59.0

TAKEOFF, HOVER, OR LAND AT T/W = 1.080 FOR 0.100 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	BHP	CT	CT/SIGMA
0.033	0.0	15.4	24839.	0.	0.0	1574.7	P	0.486	1772.	1.080	0.673	3282.	0.0074	0.061
0.043	0.0	33.1	24821.	0.	0.0	1574.3	P	0.485	1771.	1.080	0.673	3279.	0.0074	0.061
0.053	0.0	50.8	24803.	0.	0.0	1573.9	P	0.485	1769.	1.080	0.673	3276.	0.0074	0.061
0.063	0.0	68.5	24786.	0.	0.0	1573.5	P	0.484	1768.	1.080	0.673	3272.	0.0074	0.061
0.073	0.0	86.2	24768.	0.	0.0	1573.1	P	0.484	1767.	1.080	0.673	3269.	0.0074	0.061
0.083	0.0	103.8	24750.	0.	0.0	1572.7	P	0.483	1766.	1.080	0.673	3266.	0.0074	0.060
0.093	0.0	121.5	24733.	0.	0.0	1572.3	P	0.483	1765.	1.080	0.673	3262.	0.0074	0.060
0.103	0.0	139.1	24715.	0.	0.0	1571.9	P	0.482	1764.	1.080	0.673	3259.	0.0074	0.060
0.113	0.0	156.8	24697.	0.	0.0	1571.6	P	0.482	1763.	1.080	0.673	3256.	0.0074	0.060
0.123	0.0	174.4	24680.	0.	0.0	1571.2	P	0.481	1762.	1.080	0.673	3253.	0.0074	0.060
0.133	0.0	192.0	24662.	0.	0.0	1570.8	P	0.481	1761.	1.080	0.673	3249.	0.0074	0.060
0.133	0.0	192.0	24662.	0.	0.0	1570.8	P	0.481	1761.	1.080	0.673	3249.	0.0074	0.060

CLIMB TO 5000. FT, WITH MAXIMUM R/C AT NORMAL ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	BHP	R/C (FPM)
0.133	0.0	192.0	24662.	0.	84.5	1856.0	T	0.835	84.5	0.206	0.053	-2.1	6.0	2853.	913.
0.142	0.78	204.0	24650.	500.	85.5	1856.0	T	0.837	84.9	0.209	0.054	-2.1	5.7	2824.	877.
0.152	1.60	216.3	24638.	1000.	85.5	1856.0	T	0.838	84.3	0.209	0.054	-2.1	5.5	2794.	841.
0.162	2.46	229.0	24625.	1500.	85.5	1856.0	T	0.840	83.6	0.209	0.055	-2.1	5.2	2763.	805.
0.172	3.36	242.0	24612.	2000.	86.5	1856.0	T	0.841	84.0	0.211	0.056	-2.1	4.9	2733.	768.
0.183	4.31	255.6	24599.	2500.	86.5	1856.0	T	0.843	83.4	0.211	0.057	-2.1	4.7	2703.	731.
0.194	5.31	269.6	24585.	3000.	87.5	1856.0	T	0.844	83.7	0.213	0.058	-2.1	4.4	2673.	693.
0.206	6.37	284.3	24570.	3500.	87.5	1856.0	T	0.846	83.1	0.213	0.059	-2.1	4.2	2643.	655.
0.219	7.50	299.5	24555.	4000.	87.5	1856.0	T	0.847	82.5	0.213	0.059	-2.1	3.9	2612.	617.
0.233	8.70	315.6	24539.	4500.	88.5	1856.0	T	0.849	82.0	0.216	0.060	-2.1	3.6	2583.	578.
0.247	9.99	332.5	24522.	5000.	88.5	1856.0	T	0.850	82.2	0.216	0.061	-2.0	3.4	2553.	538.

CRUISE AT NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	BHP
0.247	9.99	332.5	24522.	5000.	182.7	1856.0	T	0.851	169.6	0.440	0.051	-7.9	.07753	5323.
0.357	29.99	590.5	24264.	5000.	183.5	1856.0	T	0.851	170.4	0.443	0.050	-8.1	.07789	5374.
0.466	49.99	847.2	24007.	5000.	183.8	1856.0	T	0.851	170.6	0.443	0.049	-8.2	.07800	5373.
0.574	69.99	1103.6	23751.	5000.	184.1	1856.0	T	0.851	170.9	0.444	0.048	-8.3	.07812	5371.
0.629	80.00	1231.8	23622.	5000.	184.3	1856.0	T	0.851	171.0	0.444	0.048	-8.4	.07818	5370.

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.629	80.00	1231.8	23622.	5000.
0.629	80.00	1231.8	23622.	1000.

LOITER FOR 0.500 HRS. FOR RESERVE FUEL

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	BHP
0.629	80.00	1231.8	23622.	1000.	85.0	1415.9	P	0.292	83.7	0.205	0.052	-2.1	1293.	1946.
0.679	80.00	1296.4	23558.	1000.	85.0	1415.3	P	0.291	83.7	0.205	0.052	-2.1	1291.	1940.
0.729	80.00	1361.0	23493.	1000.	84.0	1414.6	P	0.290	82.7	0.202	0.052	-2.1	1290.	1934.
0.779	80.00	1425.5	23429.	1000.	84.0	1414.0	P	0.290	82.7	0.202	0.052	-2.1	1288.	1929.
0.829	80.00	1489.9	23364.	1000.	84.0	1413.4	P	0.289	82.7	0.202	0.052	-2.1	1286.	1924.
0.879	80.00	1554.2	23300.	1000.	84.0	1412.8	P	0.288	82.7	0.202	0.052	-2.1	1285.	1918.
0.929	80.00	1618.4	23236.	1000.	84.0	1412.2	P	0.287	82.7	0.202	0.051	-2.1	1283.	1913.
0.979	80.00	1682.6	23172.	1000.	84.0	1411.6	P	0.286	82.7	0.202	0.051	-2.1	1281.	1908.
1.029	80.00	1746.7	23108.	1000.	84.0	1410.9	P	0.286	82.7	0.202	0.051	-2.1	1280.	1903.
1.079	80.00	1810.7	23044.	1000.	84.0	1410.3	P	0.285	82.7	0.202	0.051	-2.1	1278.	1898.
1.129	80.00	1874.6	22980.	1000.	84.0	1409.7	P	0.284	82.7	0.202	0.051	-2.1	1276.	1892.

CLIMB TO 3000. FT. WITH CONSTANT TAS AT NORMAL ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	EHP	R/C (FPM)
0.629	80.00	1874.6	23622.	1000.	120.0	1856.0	T	0.838	118.3	0.289	0.048	-4.2	2.6	2825.	589.
0.643	81.70	1892.8	23604.	1500.	120.0	1856.0	T	0.840	117.4	0.289	0.048	-4.2	2.6	2794.	559.
0.656	83.49	1911.7	23585.	2000.	120.0	1856.0	T	0.842	116.5	0.289	0.049	-4.1	2.5	2764.	529.
0.674	85.38	1931.5	23565.	2500.	120.0	1856.0	T	0.843	115.7	0.289	0.050	-4.1	2.3	2733.	499.
0.690	87.38	1952.2	23545.	3000.	120.0	1856.0	T	0.844	114.8	0.289	0.051	-4.1	2.2	2702.	469.

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 25.0 KNOTS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	BHP
0.694	87.38	1952.2	23545.	3000.	156.6	1605.5	P	0.543	149.8	0.378	0.047	-6.6	.07489	3532.
0.842	107.38	2215.3	23278.	3000.	156.6	1602.9	P	0.540	149.8	0.378	0.046	-6.7	.07521	3511.

0.994	127.38	2485.2	23012.	3000.	156.6	1600.4	P	0.537	149.8	0.378	0.046	-6.7	.07551	3491.
1.146	147.38	2750.1	22747.	3000.	156.6	1597.9	P	0.534	149.8	0.378	0.045	-6.8	.07581	3471.
1.290	167.38	3013.9	22483.	3000.	156.6	1595.4	P	0.531	149.8	0.378	0.044	-6.9	.07611	3451.
1.394	180.00	3179.7	22317.	3000.	156.6	1593.9	P	0.529	149.8	0.378	0.044	-7.0	.07629	3439.

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.394	180.00	3179.7	22317.	3000.
1.394	180.00	3179.7	22317.	0.

TAKEOFF, HOVER, OR LAND AT T/W = 1.080 FOR 0.100 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	BHP	CT	CT/SIGMA
1.394	180.00	3179.7	22317.	0.	0.0	1523.2	P	0.420	1625.	1.080	0.666	2840.	0.0067	0.055
1.404	180.00	3195.9	22301.	0.	0.0	1522.9	P	0.420	1624.	1.080	0.666	2838.	0.0067	0.055
1.414	180.00	3212.2	22285.	0.	0.0	1522.6	P	0.420	1623.	1.080	0.666	2835.	0.0067	0.054
1.424	180.00	3228.4	22269.	0.	0.0	1522.3	P	0.419	1622.	1.080	0.666	2832.	0.0066	0.054
1.434	180.00	3244.6	22252.	0.	0.0	1522.0	P	0.419	1621.	1.080	0.666	2830.	0.0066	0.054
1.444	180.00	3260.8	22236.	0.	0.0	1521.7	P	0.418	1620.	1.080	0.665	2827.	0.0066	0.054
1.454	180.00	3277.0	22220.	0.	0.0	1521.4	P	0.418	1620.	1.080	0.665	2825.	0.0066	0.054
1.464	180.00	3293.2	22204.	0.	0.0	1521.1	P	0.418	1619.	1.080	0.665	2822.	0.0066	0.054
1.474	180.00	3309.4	22188.	0.	0.0	1520.7	P	0.417	1618.	1.080	0.665	2819.	0.0066	0.054
1.484	180.00	3325.6	22171.	0.	0.0	1520.4	P	0.417	1617.	1.080	0.665	2817.	0.0066	0.054
1.494	180.00	3341.8	22155.	0.	0.0	1520.1	P	0.417	1616.	1.080	0.665	2814.	0.0066	0.054
1.494	180.00	3341.8	22155.	0.	0.0	1520.1	P	0.417	1616.	1.080	0.665	2814.	0.0066	0.054

MISSION FUEL REQUIRED = 2698.99
RESERVE FUEL REQUIRED = 642.79
TOTAL FUEL REQUIRED = 3341.77

****

END OF SUCCESSFUL CASE

****

7.3.3 Coaxial Rotor Helicopter with Auxiliary Propulsion

The design mission profile is illustrated in Figure 7-3. The engine and rotor cycles are not discussed in this case. A complete copy of the program printout follows the description of the input.

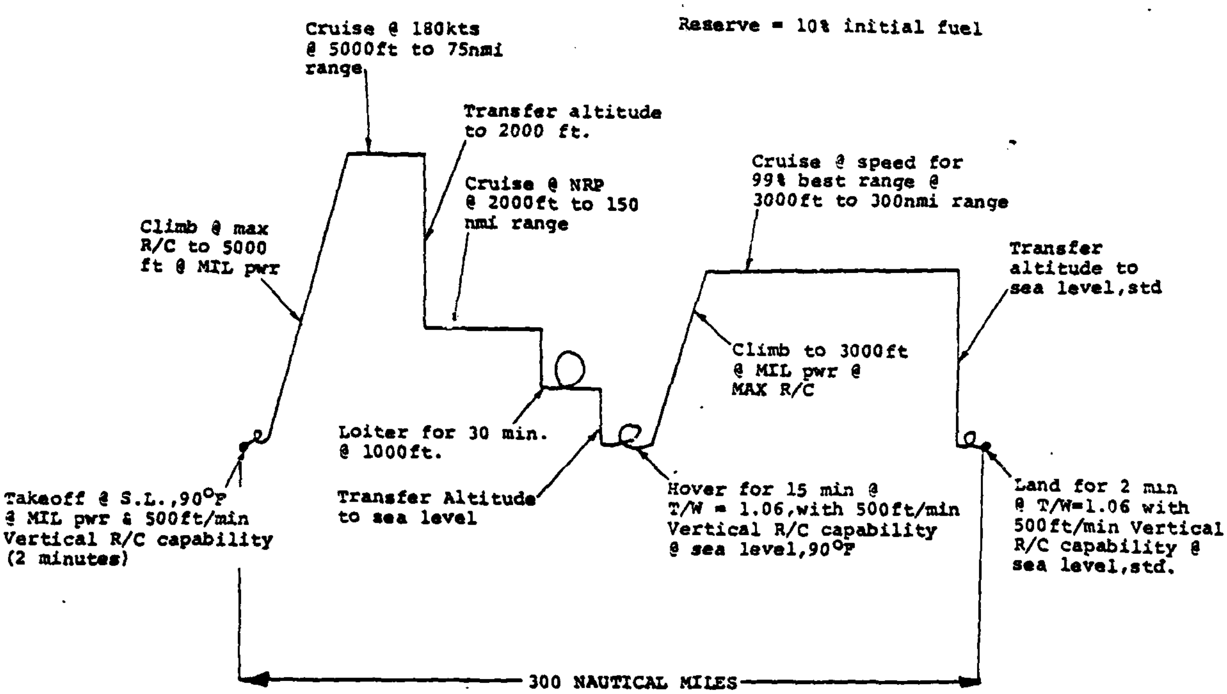


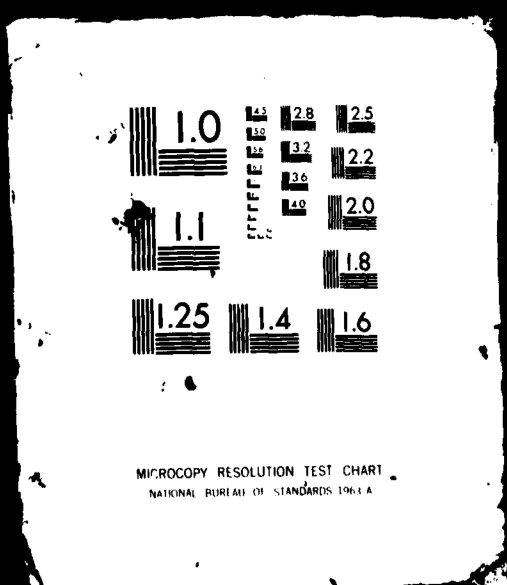
Figure 7-3. Design Mission - Sample Case No. 3

AD-A113 037 BOEING VERTOL CO PHILADELPHIA PA F/G 9/2
HESCOMP. THE HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM--ETC(U)
OCT 79 S J DAVIS, H ROSENSTEIN, K A STANZIONE N62269-79-C-0217
UNCLASSIFIED D210-10699-2-REV-2. NADC-78265-60 NL

8 9

8 OF 9

AD-A113037



SAMPLE CASE NO. 3

GENERAL INFORMATION SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
OPTIND	0001	1.0	Sizing run
OPTIONAL PRINT	0002	1.0	Detailed printout desired
DRGIND	0003	2.0	GW/Fe drag trend utilized
CNFIND	0005	1.0	Single rotor helicopter desired
AUXIND	0006	3.0	Compound helicopter with auxiliary propulsion only
RDMIND	0007	2.0	Main rotor diameter based on input disc loading. Solidity fixed by input.
FIXIND	0008	1.0	Program sizes primary engines
ROTIND	0009	4.0	Rotor figure of merit and cruise L/De maps are input
AIPIND	0012	1.0	No independent auxiliary engines. Auxiliary fans are driven through gear boxes by primary engines.
TRDIND	0015	0.0	No antitorque tail rotor on this design
HTIND	0018	2.0	Horizontal tail volume coefficient input
MRPIND	0019	0.0	Main rotor position on fuselage input by user
ESCIND	0022	2.0	Primary engines are sized for either takeoff or cruise
WG_o	0023	30000	First guess at design gross weight

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
h_O	0024	0.0	Initial altitude	Normally 0.0 except for mission analysis
R_O	0025	0.0	Initial range	
t_O	0026	0.0	Starting time	
$h_{OPT_{IND}}$	0027	0.0	Cruise at specified altitude	
M_{MO}	0028	.443	Maximum operating Mach number	
V_{MO}	0029	260	Maximum operating equivalent airspeed knots	
V_{DIVE}	0030	312	Dive speed - approximately equal to 1.2 x V_{MO} in knots	
M_{LF}	0031	3.0	Maneuver load factor	
K_1	0032	1.111	Factor on mission fuel burned to give reserve fuel. 1.111 results in 10% of initial fuel for reserve	
δW_f	0033	0.0	Fixed fuel increment for reserves or other use.	
K_{FF}	0034	1.05	Increase basic engine SFC by 5 percent	
SGTIND	0035	2.0	Takeoff	Sequence of design mission
	0036	3.0	Climb	
	0037	4.0	Cruise	
	0038	9.0	Transfer altitude	
	0039	4.0	Cruise	
	0040	9.0	Transfer altitude	
	0041	6.0	Loiter	
	0042	9.0	Transfer altitude	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
SGTIND	0043	2.0	Hover	Sequence of design mission
	0044	3.0	Climb	
	0045	4.0	Cruise	
	0046	9.0	Transfer altitude	
	0047	2.0	Land	
	0048	100.0	End of Case	

Helicopter Dimensional Information Sheet

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
AR_{HT}	0112	5.50	Horizontal tail aspect ratio
ℓ'_{TH}	0113	.775	Ratio of horizontal tail moment arm to main rotor radius
$(t/c)_{HT}$	0114	.150	Horizontal tail thickness/chord ratio
$\bar{V}_H$	0115	.020	Horizontal tail volume coefficient referred to main rotor diameter and tail arm.
λ_H	0116	.660	Horizontal tail taper ratio
$\Delta S_{WET}/S_P$	0120	0.0	Fuselage wetted area ratio
ΔS_{WT}	0121	0.0	Incremental fuselage wetted area
h_F	0122	8.17	Fuselage height
W_F	0123	[illegible]	Fuselage width
$(\ell/d)_p$	0124	1.12	Fineness ratio of nose
$(\ell/d)_T$	0125	0.688	Fineness ratio of tail
ℓ_C	0126	20.3	Constant diameter section length

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ℓ_{RW}	0127	0.0	Length of ramp well
$(X_M/\ell B)$	0128	.40	Main rotor position aft of the nose as a fraction of main fuselage length
$(\ell_{TB}/d_{\overline{TB}})$	0129	2.28	Fineness ratio of tail boom
$(d_{\overline{TT}_B}/d_{\overline{TB}})$	0130	0.205	Ratio of average tail boom tip diameter to average tail boom diameter
AR_{VT}	0135	1.5	Vertical tail aspect ratio
λ_{VT}	0136	0.50	Vertical tail taper ratio
$(t/c)_{VT}$	0137	.15	Thickness/chord ratio of vertical tail
K_z	0139	6.7	Vertical position of the tail rotor center (relative to the vertical fin root chord) as a fraction of tail rotor radius. When TRDIND=0, (as in this example), vertical tail span is input into this location.
η_1	0142	0.	Primary engine nacelle constants
η_2	0143	0.	
η_3	0144	0.	
(ℓ_{aip}/ℓ_c)	0145	0.	Ratio of air induction system length to primary engine length

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
η_4	0146	0.	Auxiliary independent engine nacelle constants
η_5	0147	0.	
η_6	0148	0.	
(ℓ_{aia}/ℓ_{ea})	0149	0.	Ratio of air induction system length to auxiliary engine length
$\Delta S/S_{str}$	0150	0.	Ratio of incremental auxiliary independent engine nacelle strut planform area to auxiliary independent engine nacelle strut planform area
$b_{NS}/d_{\overline{NI}}$	0151	0.	Ratio of auxiliary independent engine nacelle strut span to nacelle diameter
$(t/c)_{RF}$	0152	.800	Main rotor pylon root thickness/chord ratio
$(t/c)_{TF}$	0153	.600	Main rotor pylon tip thickness/chord ratio
AR_{FP}	0154	.210	Main rotor pylon aspect ratio
λ_{FP}	0155	.75	Forward rotor pylon taper ratio
h_{pl}	0156	3.58	Main rotor pylon height.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Rotor Dimensional Data for Sizing Main Rotor			
Rotor Map No.	0170	123	Coaxial rotor helicopter figure of merit and cruise L/D_E rotor map
N_R	0172	1.0	Number of rotors
W/A	0173	15.0	Main rotor disc loading
σ_{MR}	0175	0.111	Main rotor solidity
b_{MR}	0176	6.0	Number of main rotor blades
θ_{TMR}	0177	-10.0	Main rotor twist (degrees)
Xc_{MR}	0178	.10	Main rotor blade cutout as a fraction of radius
X_{MR}	0179	.05	Main rotor blade attachment point as a fraction of radius
$(t/c)_{.25R}$	0180	.32	Rotor blade thickness/chord at 25 percent radius
V_T	0181	650	Main rotor tip speed
V_{CEH1}	0191	1.60	Main rotor vertical rate of climb efficiency factors
V_{CEH2}	0192	0	
$K_{P_{CLIMB}}$	0193	.85	Helicopter forward flight climb efficiency
$K_{P_{DESCENT}}$	0194	.85	Main rotor descent efficiency

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Rotor Dimensional Data for Sizing Tail Rotor			
$g_{MR/TR}$	0214	-.5	Gap between main and tail rotor disc (FT). When TRDIND=0, represents gap between main rotor disc and end of tail boom (FT). Negative number implies tail boom ends under the main rotor disc.
$C_{L_{FIN}}$	0216	0.0	Vertical tail fin operating cruise lift coefficient
Primary Engine Sizing Information Sheet			
Primary Engine Cycle No.	0217	2.41	Primary engine selection
N_P	0219	2.0	Number of primary engines
XMSNIND	0220	0.0	Drive system ratings specified as fraction of primary engine installed power
SHP_{MRX}/SHP^*_{MR}	0221	1.02	Main rotor drive system is rated at 102% of main rotor design power
η_T	0223	0.98	Transmission efficiency
ΔSHP_{ACC}	0224	30.	Accessory power losses

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
SHP_{AUX}/SHP^{*}_{AUX}	0226	.46	Auxiliary propulsion drive system rating as a fraction of auxiliary propulsion system installed power. When no auxiliary engines are specified, this input specifies the auxiliary drive system is rated to 46% of main rotor design power
$H_{TO(H)}$	0227	0.0	Design point hover altitude for engine sizing
$(T/W)_D$	0228	1.06	Configuration design point hover thrust/weight ratio
$\Delta T_{IN\ TO}(H)$	0229	31.0	Temperature increment in degrees above standard at altitude for engine sizing
$(N_{II}/N_{IIMAX})_{T.O.}$	0230	0.8237	Operating point for engine power turbine. Operating tip speed is computed from $V_{T_{OPERATING}} = V_T \left(\frac{N_{II}}{N_{II_{MAX}}}\right)\left(\frac{N_{II_{MAX}}}{N^{*}_{II}}\right)$ To operate at V_T = 625 ft/sec requires that $N_{II}/N_{II_{MAX}}$ be the reciprocal of $\frac{N_{II_{MAX}}}{N_{II^{*}}}$
N_{PSD}	0231	0.0	Number of engines inoperative at hover design point conditions

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
SHP_E/SHP^*	0232	1.00	Engines sized to permit operation at 100% of maximum rated power
$(V_{R/C})_D$	0233	500.	500 ft/min vertical rate of climb capability required at hover design point.
POWIND	0234	2.0	Maximum engine rating for cruise engine sizing. For this example, normal rated power is the maximum rating to be used.
h_C	0235	0.0	Design point cruise altitude for engine sizing.
V_C	0236	250.	Design point cruise speed for engine sizing.
$\Delta T_{IN_{CE}}$	0237	0.	Temperature increment above standard for cruise engine sizing.
$(N_{II}/N_{II_{MAX}})_C$	0238	.7389	Operating point of engine turbine at design cruise conditions. Operating tip speed is computed from

$$V_{T_{OPERATING}} = V_T \left[\frac{N_{II}}{N_{II_{MAX}}}\right]\left[\frac{N_{II_{MAX}}}{N_{II^*}}\right]$$

The rotor is slowed to 583 ft/sec for this example. $(N_{II}/N_{II_{MAX}})$ is computed from the above equation e.g.

$$\frac{N_{II}}{N_{II_{MAX}}} = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II_{MAX}}}{N_{II^*}}\right)}$$

$$= \frac{583}{650(1.214)} = .7389$$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$(T_{AUX}/T_{TOT})_C$	0239	1.00	100% of propulsive thrust provided by auxiliary propulsion at cruise condition for engine sizing.
$(N_{PSD})_C$	0241	0.0	No. of primary engines shut down during cruise (for engine sizing)

Propeller Data Required for Compound Helicopter Auxiliary Propulsion Information Sheet

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
No. of Props.	0248	2.0	Two auxiliary propellers/fans are use on this configuration
V_{TAR}	0249	900	Auxiliary propeller tip speed
DIA	0250	4.0	Diameter of auxiliary prop/fan is 4 ft.
X_{AR}	0251	.10	Prop/fan blade attachment point as a fraction of radius
η_{TAUX}	0252	.96	Transmission efficiency of auxiliary drive system
$\eta_P IND$	0253	0.0	Table of prop/fan efficiencies are input
η_{P3}	0254	0.85	Prop/fan climb efficiency
η_{P5}	0255	0.60	Prop/fan descent efficiency

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
AF/Blade	0257	169.0	Prop/fan activity factor per blade. For this example a 13 bladed 2200 total activity prop/fan was selected.
No. of Blades	0258	13.0	Number of prop/fan blades
No. of Pairs in η_{P4} Table	0261	3.0	Number of pairs in prop/fan efficiency table
Values of Mach No.	0262	0.0	Values of Mach Number
	0263	0.5	in cruise efficiency
	0264	1.0	table
Values of η_{P_4}	0272	.60	
	0273	.75	Values of cruise efficiency
	0274	.60	
Helicopter Aerodynamics Information Sheet			
GW/Fe	0312	2020	Drag trend constants derived from data such as illustrated by Figure 4-30, Section 4.9.
K_{FED}	0313	0.561	
No. of $C_{x/\sigma}$	0347	3.	Specifies number of $C_{x/\sigma}$ values in table locations 0349-0353
No. of μ	0348	3.	Specified number of μ values in table locations 0354-0360

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Values of $C_{x/\sigma}$	0349 0350 0351	-1. 0. 1.	Rotor propulsive thrust coefficient divided by main rotor solidity. Used in defining rotor limits $C_{x/\sigma} = \frac{\text{Thrust Required}}{\rho \pi \frac{D_{mr}^2\ NR\ V_{tip}^2\ \sigma_{MR}}{4}}$
Values of μ	0354 0355 0356	0. .5 1.	Rotor forward flight advance ratio $\mu = \frac{Vfps}{Vtip}$
Values of C_T'/σ	0361 0362 0363	1. 1. 1.	Values of C_T'/σ corresponding to $(C_{x/\sigma})_1$ location 0349 and μ_1, μ_2, and μ_3.
	0368 0369 0370	1. 1. 1.	Values of C_T'/σ corresponding to $(C_{x/\sigma})_2$ location 0350 and μ_1, μ_2, and μ_3
	0375 0376 0377	1. 1. 1.	Values of C_T'/σ corresponding to $(C_{x/\sigma})_3$ location 0351 and μ_1, μ_2 and μ_3
Helicopter Weight Information Sheet			
WFE	2602	2475.	Weight of fixed equipment in lbs.
WFUL	2603	864.	Weight of fixed useful load in lbs.
WPL	2604	6328.	Weight of payload in lbs.
ΔWFC	2605	0.	Flight controls group incremental weights in lbs.
ΔWP	2606	0.	Propulsion group incremental weights in lbs.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ΔW_{ST}	2607	200.	Structures group incremental weight in lbs.
RM_1	2608	1.	Wing relief as percentage of GW.
W_i	2609	1.	Weight in inboard store.
W_o	2610	1.	Weight of outboard store.
d_i	2611	1.	Position of inboard underwing store (fraction of wing semi-span).
d_o	2612	1.	Position of outboard underwing store (fraction of wing semi-span).
k_{CC}	2613	17.5	Cockpit controls weight factor.
k_{RL}	2614	30.	Main rotor controls weight factor.
k_{SC}	2615	22.2	Main rotor system control weight factor.
k_W	2616	.005	Fixed wing controls.
k_{TM}	2617	0.	Tilt mechanism weight factor.
k_{SAS}	2618	75.	Stability Augmentation System (SAS) weight factor. Usually in the range of 20-100 pounds.
k_{RCA}	2619	.1	Auxiliary rotor controls weight factor.
k_{SCA}	2620	25.	Auxiliary rotor systems controls weight factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{MC}	2621	60.	Miscellaneous controls weight factor in LBS.
k_B	2622	125.	Body group weights factor
ΔC.G.	2623	2.	Helicopter cg travel (FT)
k_{LG}	2624	.04	Landing gear weight factor. Percentage of gross weight.
k_{MG}	2625	.8	Main landing gear weight factor.
k_{WW}	2626	0.	Detailed wing weight factor. This adjusts the constant 220 in $W_N=220\ (k)^{0.585}$ up or down depending on the complexity of the control surfaces.
LF	2627	1.	Wing unload factor. Entered as a fraction of design gross weight.
k_{WS}	2628	0.	Wing stores only weight trend factor.
k_{WP}	2629	0.	Wing weight/area factor (psf).
k_{HT}	2630	2.	Horizontal tail unit weight in PSF.
k_{CLF}	2631	0.	Crash load factor.
k_{NAC}	2632	0.	Primary cowling weight factor (PSF).
k_{AIP}	2633	276.	Primary air induction system weight factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{NACA}	2634	0.	Auxiliary cowling weight factor/PSF.
k_{AIA}	2635	0.	Auxiliary air induction system weight factor.
k_{NS}	2636	0.	Nacelles strut weight factor.
k_{PRB}	2637	52.8	Primary rotor blade weight factor.
k_{RBF}	2638	2.2	Rotor type factor; hingeless for this example.
k_{PH}	2639	73.2	Primary hub weight factor.
k_{AMD}	2640	.177	Main rotor weight factor.
k_{BLFD}	2641	1.	Blade fold weight factor. Input as a fractional part of the total rotor weight.
k_{TR}	2642	0.	Tail rotor weight factor
k_{AR}	2643	14.2	Auxiliary rotor weight factor. This is the average value for the rotor or propeller weight (LB). $W_r = 14.2a(k)^{.67}$
k_{PA}	2644	1.	Auxiliary rotor multiplicative input power, expressed here as 100% input power.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{VTAR}	2645	1.	Auxiliary tail rotor multiplicative tip speed factor expressed here as 100% input speed.
k_{PDS}	2646	250.	Primary drive system weight factor.
k_{PDSZ}	2647	3.	Primary drive system weight factor. Number of gears in system.
k_{TRDS}	2648	0.	Tail rotor drive system weight factor.
k_{ADS}	2649	250.	Auxiliary drive system weight factor.
k_{ADSZ}	2650	3.	Auxiliary drive system weight factor (number of gears in system).
k_{FS}	2651	.08	Fuel system weight factor.
k_{PEI}	2652	.17	Primary engine installation weight factor.
k_{AEI}	2653	0.	Auxiliary engine installation weight factor.
K_1	2654	1.	Main rotor controls weight factor.
K_2	2655	.8	Main rotor system controls weight multiplicative factor.
K_3	2656	1.	Fixed wings controls weight multiplicative factor.
K_4	2657	1.	Auxiliary rotor controls weight multiplicative factor.
K_5	2658	1.	Auxiliary rotor system controls weight multiplicative factor.
K_6	2659	1.	Body weight multiplicative factor.
K_7	2660	1.	Landing gear weight multiplicative factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
K_8	2661	1.	Wing weight multiplicative factor.
K_9	2662	1.	Horizontal tail weight multiplicative factor.
K_{10}	2663	1.	Primary nacelle weight multiplicative factor.
K_{11}	2664	1.	Auxiliary nacelle weight multiplicative factor.
K_{12}	2665	1.22	Primary rotor blade weight multiplicative factor.
K_{13}	2666	4.16	Primary rotor kit weight multiplicative factor.
K_{14}	2667	1.	Tail rotor weight multiplicative factor.
K_{15}	2668	1.	Auxiliary rotor weight multiplicative factor.
K_{16}	2669	1.	Primary drive system weight multiplicative factor.
K_{17}	2670	1.	Auxiliary drive system weigh multiplicative factor.
K_{18}	2671	1.	Primary engine weight multiplicative factor.
K_{19}	2672	1.	Auxiliary engine weight multiplicative factor.

Takeoff, Hover, and Landing Information

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
TOLIND	0461	2.0	Specify power fraction and vertical rate of climb
	0462	1.0	Specify required T/W for hover out of ground effect.
	0463	1.0	
ATMIND	0481	1.00	Standard atmosphere plus an incremental temperature
	0482	1.00	
	0483	0.0	Standard atmosphere
PEHF	0491	1.00	Power fraction - 100 percent of power available at these ambient conditions is being used.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
POWIND	0781	2.0	Cruise speed
	0782	2.0	by normal rated
	0783	2.0	primary engine power
R_{MAX}(N.M.)	0791	75.0	Values of range
	0792	150.0	at end of each
	0793	300.0	cruise segment
$(N_{II}/N_{II_{MAX}})$ (Primary Engine)	0801	.8237	Operating point for engine power turbine during cruise.
	0802	.7389	
	0803	.8237	$\frac{N_{II}}{N_{II_{MAX}}} = \frac{V_{T_{OPERATING}}}{V_T \left(\frac{N_{II_{MAX}}}{N_{II}^*}\right)}$
$\Delta fe_{CR}(FT^2)$	0811	1.0	Increment in cruise
	0812	0.0	equivalent flat plate
	0813	1.0	area (FT^2)
$N_{PSD_{CR}}$	0831	0.0	Number of primary
	0832	0.0	engines shut down
	0833	0.0	in cruise
T_{AUX}/T_{TOT}	0841	1.0	100% of required
	0842	1.0	propulsive force is
	0843	1.0	provided by auxiliary
			prop/fans
Loiter Information Sheet			
ATMIND	1031	0.0	Standard atmosphere specified
Δt_L (HR)	1061	.100	Time increments for loiter calcuations

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ΔT_{IN}(°F)	0401	31.0	Incremental temperature above standard, in degrees.
	0502	31.0	
$V_{R/C}$(FPM)	0511	500.	500 ft/min vertical rate of climb capability desired
	0512	500.	
	0513	500.	
T/W	0522	1.06	Hover thrust/weight ratio specified.
	0523	1.06	
ΔT_H(HR)	0531	.0111	Time increments for
	0532	.050	takeoff, hover or landing
	0533	.0111	computation in hours.
$(N_{II}/N_{II_{MAX}})$ (Primary Engine)	0541	.8237	Operating point for engine power turbine during takeoff, hover or landing.
	0542	.8237	
	0543	.8237	$\frac{N_{II}}{N_{II_{MAX}}} = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II_{MAX}}}{N_{II}^*}\right)} =$ $\frac{650}{650(1.214)} = .8237$
t_H(HR)	0551	.0333	Takeoff, hover,
	0552	.250	or landing
	0553	.0333	total time in hours.
Climb Information Sheet			
CLMIND	0571	1.0	Maximum rate of
	0572	1.0	climb desired
ATMIND	0571	0.0	Atmosphere indicator. Standard atmosphere specified.
	0592	0.0	
Δh(FT)	0621	500.	Altitude increments for climb calculations.
	0622	300.	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
POWIND	0631	1.0	Climb at maximum rate of climb, limited by military power available.
	0632	1.0	
h_{MAX}(FT)	0641	5000.	Final altitudes for climb.
	0642	3000.	
$(N_{II}/N_{II_{MAX}})$ (Primary Engine)	0651	.8237	Operating point for engine turbine during climb.
	0652	.8237	$\frac{N_{II}}{N_{II_{MAX}}} = \frac{V_{T_{OPERATING}}}{V_T \frac{N_{II_{MAX}}}{N_{II}^*}} = .8237$
$\Delta fe_{CL}(FT^2)$	0661	.500	Incremental drag area in climb
	0662	.500	
$N_{PSD_{CL}}$	0681	0.0	Number of primary engines shut down during climb
	0682	0.0	
T_{AUX}/T_{TOT}	0691	.300	30% of required propulsive force provided by auxiliary fans.
	0692	.300	
Cruise Information Sheet			
CRSIND	0721	2.0	Cruise at constant true airspeed
	0722	1.0	Cruise at specified power setting
	0723	4.0	Cruise at 99% best range speed
	0731	180.	Cruise at 280 knots T.A.S.
ATMIND	0741	0.0	Atmosphere indicator
	0742	0.0	Standard atmosphere
	0743	0.0	specified
ΔR(N.M)	0771	15.0	Calculation increments
	0772	15.0	during cruise in
	0773	15.0	nautical miles

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$(N_{II}/N_{II_{MAX}})$ (Primary Engines)	1071	.8237	Operating point for primary engine power turbine during loiter. $\frac{N_{II}}{N_{II_{MAX}}} = \frac{V_{T_{OPERATING}}}{V_T \frac{N_{II_{MAX}}}{N_{II}^*}} = .8237$
t_L(RH)	1081	.500	30 minutes of loiter specified
$N_{PSD_{LOITER}}$	1101	0.0	Number of primary engines shut down during loiter
T_{AUX}/T_{TOT}	1111	.30	30% of required propulsive force is provided by auxiliary prop/fans.
$\Delta fe_L(FT^2)$	1131	.500	Increment in loiter equivalent flat plate drag area (FT^2)
Transfer Altitude Sheet			
h_{FINAL}(FT)	1181	2000.	Transfer altitude to
	1182	1000.	these final values
	1183	0.0	with no time, fuel or
	1184	0.0	distance credits
Primary Engine Cycle Data; Non-Standard Performance			
WDTIND	1201	0.0	No fuel flow cutoffs
N1IND	1202	0.0	No N_I cutoffs
N1θIND	1203	1.0	Referred N_I cutoff
N2IND	1204	2.0	Free turbine engine to be simulated
QIND	1205	1.0	Torque cutoff
RNOIND	1206	0.0	No Reynolds No. corrections
$(N_I/\sqrt{\theta_1}/N_I^*)$MAX	1222	1.115	Value for referred N_I limit
$(N_{II_{MAX}}/N_{II}^*)$	1223	1.214	Value for N_{II} cutoff referred to N_{II}^*

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Q_{MAX}/Q^*	1224	1.00	Value of torque cutoff referred to value at sea level standard static condition

SAMPLE CASE NO. 3 Run 2

QIND	1205	2.	Torque limit imposed on auxiliary propulsion transmission.

SAMPLE CASE NO. 3 Run 3

XMSNIND	0220	1.	When XMSNIND = 0. or 1. the transmission can be rated either takeoff or cruise. In this example ESCIND (LOC 0022)=2. This internally sets the maximum power to the cruise power in location 0238. XMSNIND = 1 indicates that the drive system component (main tail, and auxiliary) power is obtained from the proportional split of the total sea level standard power.

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM R-91

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+0001
VAL2 VALUE CORRESPONDING TO LOC.+0002
ETC.

NOTE : IN USING AUXILIARY ENGINES : AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
1201	5	.0	.0	1.0000	2.0000	1.0000
1206	1	.0				
1222	3	1.1150	1.2140	1.0000		
1301	3	2.4100	.15750	.0		
1305	2	1725.0	1740.0			
1307	3	2500.0	2580.0	2660.0		
1310	1	8.0000				
1311	5	1625.0	1900.0	2100.0	2400.0	2650.0
1316	3	2900.0	3150.0	3400.0		
1319	1	5.0000				
1320	5	.0	.20000	.40000	.60000	.70000
1326	5	.0	.0	.0	.0	.0
1332	5	.15600	.16200	.17000	.19200	.21400
1338	5	.40600	.43100	.46100	.52100	.55100
1344	5	.74000	.77800	.81600	.90800	.95900
1350	5	.98600	1.0450	1.0962	1.2452	1.3141
1356	5	1.2300	1.3140	1.3880	1.5440	1.623 [illegible]
1362	5	1.4500	1.5500	1.6440	1.8290	1.918 [illegible]
1368	5	1.6300	1.7500	1.8600	2.0740	2.212 [illegible]
1374	1	8.0000				
1375	5	1625.0	1900.0	2100.0	2400.0	2650.0
1380	3	2900.0	3150.0	3400.0		
1383	1	5.0000				
1384	5	.0	.20000	.40000	.60000	.70000
1390	5	.48000E-01	.46000E-01	.46000E-01	[illegible]E-01	.49 [illegible] E-01
1396	5	.10500	.10600	.10700	[illegible]	.10900
1402	5	.20500	.21000	.21400	.225 [illegible]	.23 [illegible]
1408	5	.32400	.33400	.34300	.357 [illegible]	.36 [illegible]
1414	5	.42100	.43400	.44500	.47700	.494
1420	5	.50300	.52400	.54300	.58800	.612 [illegible]
1426	5	.57400	.60300	.63400	.69 [illegible]	.715
1432	5	.64500	.66800	.72600	.791 [illegible]	.825 [illegible]
1438	1	8.0000				
1439	5	1625.0	1900.0	2100.0	2400.0	2650.0
1444	3	2900.0	3150.0	3400.0		
1447	1	5.0000				
1448	5	.0	.20000	.40000	.6 [illegible]	.7 [illegible]
1454	5	.654 [illegible]	.65400	.654 [illegible]	.654 [illegible]	.654 [illegible]

1460	5	.750[illegible]	.74900	.74800	.74800	.74700
1466	5	.85660	.85500	.85400	.85300	.852[illegible]
1472	5	.938[illegible]	.93700	.93600	.93500	.93400
1478	5	.998[illegible]	.99730	.99500	.9940[illegible]	.993[illegible]
1484	5	1.0540	1.0530	1.052[illegible]	1.05[illegible]	1.049[illegible]
1490	5	1.1090	1.1060	1.1050	1.1030	1.1020
1496	5	1.1580	1.1570	1.1560	1.1530	1.152[illegible]
1502	1	8.3000				
1503	5	1625.0	1600.0	2130.0	2490.0	265[illegible]
1508	3	2908.0	3150.0	3400.0		
1511	1	5.3000				
1512	5	.0	.26000	.40000	.65000	.7[illegible]
1518	5	.287[illegible]	.28230	.30600	.33900	.34500
1524	5	.527[illegible]	.53400	.54200	.55900	.56400
1530	5	.751[illegible]	.75800	.76600	.76600	.795[illegible]
1536	5	.899[illegible]	.90900	.91800	.93600	.946[illegible]
1542	5	.99400	1.0010	1.011[illegible]	1.050	1.040[illegible]
1548	5	1.068[illegible]	1.0770	1.089[illegible]	1.1090	1.1240
1554	5	1.1310	1.1430	1.152[illegible]	1.1730	1.1860
1560	5	1.1800	1.1920	1.2020	1.2230	1.237[illegible]
4101	5	.0	2.1500	4.0000	5.6000	6.1000
4106	5	5.8500	5.2000	4.4000	3.5000	2.55[illegible]
4111	5	.0	1.7000	3.1100	4.3[illegible]	4.8900
4116	5	4.49[illegible]	4.5600	4.[illegible]	3.4[illegible]	2.75[illegible]
4121	5	.0	1.3000	2.5600	3.2500	3.550[illegible]
4126	5	3.5520	3.4[illegible]	3.2500	2.9000	2.53[illegible]
3420	1	123.00				
3421	3	6.0[illegible]	.11100	-10.000		
3424	1	1[illegible]				
3425	5	.2000[illegible]E-01	.40000E-01	.50000E-01	.60000E-01	.7[illegible]E-1
3430	5	.80000E-01	.12000	.16000	.2[illegible]	.3[illegible]
3435	1	3.0000				
3436	3	.53000	.65000	.80000		
3442	5	.36800	.59800	.64800	.68100	.70[illegible]
3447	5	.723[illegible]	.74700	.741[illegible]	.721[illegible]	.7[illegible]
3452	5	.36800	.59800	.64800	.68100	.7[illegible]
3457	5	.723[illegible]	.74700	.741[illegible]	.721[illegible]	.7[illegible]
3462	5	.368[illegible]	.59800	.64800	.68100	.70600
3467	5	.723[illegible]	.74700	.741[illegible]	.721[illegible]	.7[illegible]
3502	1	6.[illegible]				
3503	5	-.20000	-.10000	-.50000E-01	.	.5[illegible]E-1
3508	1	.1[illegible]				
3509	1	10.000				
3510	5	.0	.2[illegible]E-01	.40000E-01	.60000E-01	.80000E-01
3515	5	.10000	.12000	.14000	.16[illegible]	.18[illegible]
3520	1	1[illegible]				
3521	5	.10000E-01	.50000E-01	.15000	.15000	.21[illegible]
3526	5	.3[illegible]	.35000	.47[illegible]	.6[illegible]	.91[illegible]
3531	5	.0	.60000	.91000	1.0000	1.1[illegible]
3536	5	.7[illegible]	.42000	.20000	.11[illegible]	.9[illegible]E-1
3541	5	.0	1.0000	3.0600	3.81[illegible]	3.95[illegible]
3546	5	2.61[illegible]	1.8000	1.2500	.620[illegible]	.42[illegible]
3551	5	.0	2.6500	4.36[illegible]	5.[illegible]	5.9[illegible]
3556	5	4.2100	3.2500	2.4500	1.7100	1.0600
3561	5	.0	2.8000	5.000[illegible]	[illegible]	[illegible]
3566	5	5.45[illegible]	4.6000	3.6[illegible]	2.[illegible]	1.91[illegible]
3571	5	.0	2.7000	4.9000	6.2[illegible]	6.55
3576	5	6.15[illegible]	5.55[illegible]	4.[illegible]	3.0[illegible]	2.9
3581	5	.0	2.8[illegible]	4.6600	5.2100	5.39[illegible]
3586	5	6.52[illegible]	6.32[illegible]	6.11[illegible]	5.72[illegible]	5.21[illegible]

3591	5	.0	1.9000	3.4000	4.6000	5.4500
3596	5	6.0000	6.2500	6.3500	6.3500	6.2500
3601	5	.0	1.2000	2.3000	3.2500	4.0500
3606	5	4.7000	5.1500	5.4500	5.5000	5.1500
3611	5	.0	1.0000	1.9400	2.7500	3.3400
3616	5	3.8200	4.1900	4.4500	4.5000	4.4000
3621	5	.0	.85000	1.6000	2.3000	2.9000
3626	5	3.4500	3.8500	4.0500	4.1000	3.9000
3631	5	.0	.51000	.85000	.91000	.80000
3636	5	.60000	.38000	.22000	.11000	.60000E-01
3641	5	.0	1.5600	2.6500	2.6100	2.1800
3646	5	1.7800	1.3100	1.0500	.78000	.52000
3651	5	.0	2.6500	4.2600	4.5500	4.0000
3656	5	3.3100	2.9000	2.4500	1.7000	1.2200
3661	5	.0	3.2500	5.3800	6.3000	5.7100
3666	5	5.0000	4.4200	3.7800	3.0400	2.1900
3671	5	.0	3.5500	6.0000	7.3500	7.4500
3676	5	6.9500	6.3000	5.5000	4.5500	3.5000
3681	5	.0	3.2800	6.1100	8.2000	9.7000
3686	5	9.9400	9.1500	6.1500	7.1800	6.1000
3691	5	.0	3.0500	5.7500	8.0000	9.8000
3696	5	10.500	10.200	9.4500	8.4500	7.5500
3701	5	.0	2.0000	3.6000	4.8500	5.9000
3706	5	6.6900	7.0500	7.2500	7.0500	6.3000
3711	5	.0	1.5800	2.6200	3.6200	4.3500
3716	5	4.9000	5.3000	5.5000	5.4200	5.3500
3721	5	.0	1.0500	2.0000	2.8500	3.5500
3726	5	4.1500	4.6000	4.8000	4.7500	4.4000
3731	5	.0	.38000	.59000	.60000	.49000
3736	5	.40000	.32000	.21000	.16000	.10000
3741	5	.0	1.4800	2.5000	2.5000	2.0000
3746	5	1.7000	1.4500	1.2000	.91000	.56000
3751	5	.0	2.4600	4.0500	4.4100	3.9000
3756	5	3.4000	2.9200	2.4500	1.9000	1.2600
3761	5	.0	3.1600	5.2500	5.8000	5.5000
3766	5	4.8500	4.2200	3.5800	2.8200	2.0500
3771	5	.0	3.5000	6.0000	7.1500	7.1000
3776	5	6.5500	5.8500	5.0500	4.1500	3.1500
3781	5	.0	3.3500	6.1400	8.1000	8.9000
3786	5	8.6800	8.0000	7.1400	6.1000	5.0500
3791	5	.0	3.0500	5.7500	7.9500	9.1500
3796	5	9.2000	8.7000	7.9000	7.0000	6.0000
3801	5	.0	2.1500	4.0000	5.6000	6.8000
3806	5	7.6000	8.0000	7.7500	6.9500	5.9500
3811	5	.0	1.6000	3.0800	4.3800	5.4800
3816	5	6.3400	6.8900	7.0800	6.8800	6.4500
3821	5	.0	1.3000	2.5000	3.6000	4.4000
3826	5	5.0000	5.4000	5.5500	5.3500	5.0000
3831	5	.0	.40000	.56000	.55000	.45000
3836	5	.38000	.26000	.18000	.11000	.80000E-01
3841	5	.0	1.4300	2.9600	2.2000	1.7900
3846	5	1.4800	1.1400	.91000	.75000	.52000
3851	5	.0	2.3900	3.5700	3.7900	3.3600
3856	5	2.7910	2.3200	2.0000	1.6100	1.0800
3861	5	.0	3.1000	4.7300	5.2500	4.9100
3866	5	4.3200	3.7100	3.1400	2.5000	1.6800
3871	5	.0	3.5000	5.9000	6.7600	6.5000
3876	5	5.9500	5.3500	4.5500	3.7000	2.7000
3881	5	.0	3.3500	6.2200	7.9100	8.6000
3886	5	8.2900	7.6000	6.7200	5.7100	4.5800

3891	5	.0	3.6500	5.7500	7.6500	8.8500
3896	5	8.8000	8.2000	7.4000	6.5000	5.5000
3901	5	.0	2.1500	4.0000	5.6000	6.8300
3906	5	7.4500	7.4500	6.9000	6.0000	5.0000
3911	5	.0	1.6500	3.1100	4.4000	5.4500
3916	5	6.2100	6.6900	6.6500	5.9800	4.9500
3921	5	.0	1.3000	2.5000	3.6[illegible]	4.4000
3926	5	5.3000	5.2500	5.2500	5.0000	4.6000
3931	5	.0	.41000	.63000	.55000	.37000
3936	5	.25000	.19600	.13000	.10000	.90000E-01
3941	5	.0	1.4100	1.9900	1.9800	1.6500
3946	5	1.4200	1.1900	.98000	.71000	.49000
3951	5	.0	2.3500	3.3900	3.4100	3.1900
3956	5	2.8200	2.3800	1.9000	1.4200	.93000
3961	5	.0	3.1000	4.5000	4.7900	4.5000
3966	5	4.0300	3.5900	2.8500	2.1900	1.5100
3971	5	.0	3.5000	5.6500	6.3000	6.0000
3976	5	5.5000	4.5900	4.1500	3.3000	2.3500
3981	5	.0	3.3400	6.0000	7.4200	7.6000
3986	5	7.3000	6.7200	5.9200	4.9000	3.7500
3991	5	.0	3.0500	5.7500	7.3000	8.0000
3996	5	7.8000	7.1500	6.3500	5.4000	4.4500
4001	5	.0	2.1500	4.0000	5.6000	6.7000
4006	5	6.9500	6.5000	5.7000	4.7500	3.7000
4011	5	.0	1.7000	3.2500	4.5000	5.5000
4016	5	5.9100	5.6000	5.4600	4.9000	4.1800
4021	5	.0	1.3000	2.6000	3.6000	4.2500
4026	5	4.4500	4.4500	4.3000	4.0000	3.6500
4031	5	.0	.55000	.65000	.5[illegible]	.32000
4036	5	.21000	.16000	.10000	.81000E-01	.60000E-01
4041	5	.0	1.7600	2.3300	2.0000	1.5600
4046	5	1.2000	.98000	.79000	.63000	.5[illegible]
4051	5	.0	2.2000	3.6300	3.5900	2.9400
4056	5	2.4000	2.1000	1.6800	1.4[illegible]	.99000
4061	5	.0	3.3200	4.6100	4.7200	4.1700
4066	5	3.5900	3.0600	2.6500	2.1400	1.4300
4071	5	.0	3.5000	5.4000	5.8000	5.5000
4076	5	5.3500	4.4500	3.7500	2.9500	2.[illegible]
4081	5	.0	3.3200	5.6000	6.5300	6.5500
4086	5	6.1250	5.4900	4.7000	3.3500	2.[illegible]
4091	5	.0	3.[illegible]	5.4500	6.6000	6.7000
4096	5	6.2500	5.6000	4.8500	4.[illegible]	3.1500
1	5	1.3000	1.0000	2.0000	.0	1.0000
6	4	3.0000	2.0000	1.0000	4.0000	
12	1	1.0000				
15	1	.0				
18	2	2.[illegible]	.0			
22	5	2.[illegible]	3[illegible]0.	.0	.0	.0
27	5	.0	.44300	260.00	312.0	3.[illegible]
32	3	1.1111	.0	1.0500		
35	5	2.3000	3.6000	4.0000	9.0000	4.0000
40	5	5.[illegible]	6.0000	9.0000	2.[illegible]	3.0000
45	4	4.[illegible]	9.[illegible]	2.0000	1[illegible]	
112	5	5.5000	.77500	.15000	.2[illegible]E-01	.66[illegible]
120	5	.0	.0	4.17[illegible]	8.33[illegible]	1.12[illegible]
128	5	.68800	2[illegible].300	.0	.40000	2.2600
132	1	.2750				
135	3	1.5000	.5[illegible]	.15000		
139	1	6.7000				
142	5	.0	.0	.0	.0	.0

147	5	.0	.0	.0	.0	.0
152	5	.90000	.60000	.21000	.75000	3.5000
170	1	123.00				
172	2	1.0000	15.000			
175	5	.11100	6.0000	-10.000	.10010	.50000E-01
180	2	.32000	650.00			
191	2	1.6000	.0			
193	2	.85000	.65000			
214	1	-.50000				
216	1	.0				
217	1	2.4100				
219	3	2.0000	.0	1.0200		
223	2	.98000	30.000			
226	1	.46000				
227	5	.0	1.1600	31.000	.82370	.0
232	5	1.0000	500.00	2.0000	.0	255.00
237	3	.0	.73000	1.0000		
241	1	.0				
248	5	2.0000	900.00	4.0000	.13000	.96000
253	1	.0				
254	2	.65000	.60000			
257	2	169.00	13.000			
261	1	3.0000				
262	3	.0	.50000	1.0000		
272	3	.60000	.75000	.60000		
312	2	2020.0	.56100			
2602	3	2475.0	864.00	6328.0		
2605	3	.0	.0	200.00		
2608	5	1.0000	1.0000	1.0000	1.0000	1.0000
2613	5	17.500	30.000	22.200	.50000E-02	.0
2618	4	75.000	.10000	25.000	60.000	
2622	5	125.00	2.0000	.40000E-01	.80000	.0
2627	5	1.0000	.0	.0	2.4000	.0
2632	5	.0	276.00	.0	.0	.0
2637	5	52.800	2.2000	73.200	.17700	1.0000
2642	5	.0	14.200	1.0000	1.0000	255.00
2647	5	3.0000	.0	255.00	3.0000	.80000E-01
2652	2	.17000	.0			
2654	5	1.0000	.60000	1.0000	1.0000	1.0000
2659	5	1.0000	1.0000	1.0000	1.0000	1.0000
2664	1	1.0000				
2665	5	1.2200	4.1600	1.0000	1.0000	1.0000
2671	3	1.0000	1.[illegible]	1.1000		
347	5	3.0000	3.0000	-1.0000	.0	1.0000
354	3	.0	.50000	1.0000		
361	3	1.0000	1.0000	1.0000		
368	3	1.0000	1.0000	1.0000		
375	3	1.2000	1.0000	1.0000		
461	3	2.0000	1.0000	1.0000		
481	3	1.0000	1.0000	.0		
491	1	1.0000				
501	2	31.000	31.000			
511	3	500.00	500.00	510.00		
522	2	1.3600	1.0000			
531	3	.111[illegible]E-01	.5[illegible]E-01	.111[illegible]E-01		
541	3	.82370	.82370	.82370		
551	3	.333[illegible]E-01	.25000	.333[illegible]E-01		
571	2	1.0000	1.0000			
581	2	.0	.0			
621	2	5[illegible]	3[illegible]			

631	2	1.0000	1.0000		
641	2	5000.0	3000.0		
651	2	.82370	.82370		
661	2	.50000	.50000		
681	2	.0	.0		
691	2	.30000	.30000		
721	3	2.0000	1.0000	4.0000	
731	1	100.00			
741	3	.0	.0	.0	
771	3	15.000	15.000	15.000	
781	3	2.0000	2.0000	2.0000	
791	3	75.000	150.00	300.00	
801	3	.82370	.73890	.82370	
811	3	1.0000	.0	1.0000	
831	3	.0	.0	.0	
841	3	1.0000	1.0000	1.0000	
1031	1	.0			
1061	1	.10000			
1071	1	.82370			
1081	1	.50000			
1101	1	.0			
1111	1	.30000			
1131	1	.50000			
1181	4	2000.0	1000.0	.0	.0
1309	1	2580.0			

WG = 0.300000E+05 WFA = 0.0 WFR = 0.0
WG = 0.300000E+05 WFA = 0.312492E+04 WFR = 0.527823E+04
WG = 0.330762E+05 WFA = 0.465469E+04 WFR = 0.573333E+04

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   H-91

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER

S I Z E   D A T A   THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 36164. LB

FUSELAGE

LF	LENGTH(BODY+TAILBOOM)	41.3 FT.
LC	LENGTH(CABIN)	20.3 FT.
LB	LENGTH(BODY)	35.2 FT.
LTB	LENGTH(TAILBOOM)	6.1 FT.
XM	FWD. ROTOR LOCATION	14.1 FT.
WF	WIDTH	6.3 FT.
SF	WETTED AREA	861.3 SQ. FT.

WING - NO WINGS USED

HOR. TAIL

ARHT	ASPECT RATIO	5.500
SHT	AREA	97.7 SQ. FT.
BHT	SPAN	23.2 FT.
CBARHT	MEAN CHORD	4.2 FT.
LAMBDA H	TAPER RATIO	.667
(T/C)HT	THICKNESS/CHORD	0.150
LTH	HOR. TAIL ARM	21.5 FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.5[illegible]
SVT	AREA	29.9 SQ. FT.
BVT	SPAN	6.7 FT.
CBARVT	MEAN CHORD	4.5 FT.
LAMBDA VT	TAPER RATIO	.5[illegible]
ZTR	TAIL ROTOR(VERT.) LOCATION	[illegible] FT.
ZETAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	0.0
(T/C)VT	THICKNESS/CHORD	.15

MAIN ROTOR PYLON

AP	ASPECT RATIO	.21
SFP	WETTED AREA	1[illegible] SQ. FT.
FAFP	FRONTAL AREA	43.6 SQ. FT.
HP1	HEIGHT	3.6 FT.
CBARFP	MEAN CHORD	17.[illegible] FT.
LAMBDA FP	TAPER RATIO	.75[illegible]
(T/C)P	ROOT THICKNESS/CHORD	[illegible]
(T/C)T	TIP THICKNESS/CHORD	.6[illegible]

PRIMARY ENGINE NACELLE

LN	LENGTH	0.0 FT.
DN	MEAN DIAMETER	0. FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	0.0 SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION)

DAR	DIAMETER	4.0 FT.
AF	ACTIVITY FACTOR PER BLADE	169.0
SIGAR	SOLIDITY	0.297
NRA	NO. OF PROPELLERS	2.
NO. BLADES	NO. OF BLADES/PROP	13.
VTIP	TIP SPEED	900. FT./SEC

MAIN ROTOR

DMR	DIAMETER	55.4 FT.
SIGMR	SOLIDITY	0.111
WE/A	DISC LOADING	15.0 LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.0
NR	NO. OF ROTORS	1.
NO. BLADES	NO. OF BLADES/ROTOR	6.
THETA	BLADE TWIST	-10.000 DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.100
VTIP	TIP SPEED	650. FT./SEC.

- NO TAIL ROTOR USED

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

W E I G H T S   D A T A   IN LBS

MLF		MANEUVER LOAD FACTOR	3.000		
ULF		ULTIMATE LOAD FACTOR	4.500		
PROPULSION GROUP					
	WPRG	TOTAL MAIN ROTOR GROUP	6392.		
K12	WBRP	MAIN ROTOR BLADE (PER ROTOR)		2604.	
K13	WPH	MAIN ROTOR HUB (PER ROTOR)		3788.	
	WBF	BLADE FOLDING(PER ROTOR)		0.	
K15	WAP	AUXILIARY PROPULSION ROTOR GROUP	343.		
	WDS	DRIVE SYSTEM	4503.		
K16	WDDS	MAIN ROTOR DRIVE SYSTEM		4165.	
K20	WTRDS	TAIL ROTOR DRIVE SYSTEM		0.	
K17	WADS	AUXILIARY PROPULSION DRIVE SYSTEM		338.	
K18	WEP	PRIMARY ENGINES	1573.		
K19	WEA	AUXILARY ENGINES	0.		
	WPEI	PRIMARY ENGINE INSTALLATION	267.		
	WAEI	AUXILIARY ENGINE INSTALLATION	0.		
	WFS	FUEL SYSTEM	495.		
DELTA	WP	PROPULSION GROUP WEIGHT INCREMENT	0.		
	WP	TOTAL PROPULSION GROUP WEIGHT			13573.
STRUCTURES GROUP					
K8	WW	WING	0.		
	WTG	TAIL GROUP	195.		
K9	WHT	HOR. TAIL		195.	
K14	WTR	TAIL ROTOR		0.	
K6	WB	FUSELAGE	3264.		
K7	WLG	LANDING GEAR	1447.		
	WNG	NOSE GEAR		[illegible]	
	WMG	MAIN GEAR		1157.	
	WTES	TOTAL ENGINE SECTION	276.		
	WPES	PRIMARY ENGINE SECTION		276.	
	WAES	AUXILIARY ENGINE SECTION		0.	
DELTA	WST	STRUCTURE WEIGHT INCREMENT	210.		
	WST	TOTAL STRUCTURE WEIGHT			5392.
FLIGHT CONTROLS GROUP					
	WPFC	PRIMARY FLIGHT CONTROLS	1135.		
	WCC	COCKPIT CONTROLS		76.	
K1	WRC	MAIN ROTOR CONTROLS		[illegible]	
K2	WSC	MAIN ROTOR SYSTEMS CONTROLS		713.	
K3	WFW	FIXED WING CONTROLS		[illegible]	
	WTM	TILT MECHANISM		0.	
	WSAS	SAS		75.	
	WAFC	AUXILIARY FLIGHT CONTROLS	[illegible]		
K4	WPCA	AUX. PROPULSION ROTOR CONTROLS		74.	
K5	WSCA	AUX. PROPULSION ROTOR SYS. CONTROLS		126.	

WMC	MISCELLANEOUS CONTROLS	60.
DELTA WFC	CONTROL WEIGHT INCREMENT.	0.
WFC	TOTAL CONTROL WEIGHT	1355.
WFE	WEIGHT OF FIXED EQUIPMENT	2475.
WE	WEIGHT EMPTY	22782.
WFUL	FIXED USEFUL LOAD	864.
OWE	OPERATING WEIGHT EMPTY	23646.
WPL	PAYLOAD	6328.
(WF)A	FUEL	6190.
WG	GROSS WEIGHT	36164.

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM 8-91

R O T O R D A T A

FIXED MAIN ROTOR SOLIDITY INPUT

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                    H E S C O M P
   HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM     F-91


P R O P U L S I O N   D A T A
      PRIMARY PROPULSION CYCLE NO.      2.411
            TURBOSHAFT ENGINE

             2.  ENGINES

         PHP=P          MAX. STANDARD S.L. STATIC H.P.          9971.     H.P.

         ENGINE SIZED FOR CRUISE AT VC = 250. KNOTS,
          NORMAL  POWER SETTING,  99.7 PERCENT HOVER RPM,
         TAUX/T = 1.000, HC =     0. FT, TEMPERATURE =  59.00 DEG.F.,
         AND  0.   ENGINES INOPERATIVE.

      NO AUX. INDEPENDENT ENGINE CYCLE SELECTED


            MAIN ROTOR DRIVE SYSTEM RATING          1 17.      H.P.

      XMSN SIZED AT 102. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
      (MAX. STANDARD S.L. STATIC H.P.),  99.7 PERCENT HOVER RPM

            AUXILIARY PROPULSION DRIVE SYSTEM RATING          4587.     H.P.

      XMSN SIZED AT  46. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
      (MAX. STANDARD S.L. STATIC H.P.),  99.7 PERCENT HOVER RPM
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                         H E S C O M P,
       HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    R-91

A E R O D Y N A M I C S   D A T A
           FE            TOTAL EFFECTIVE FLATPLATE AREA         16.493     SQFT
           SWET          TOTAL WETTED AREA                       1292.     SQFT
           CBARF         MEAN SKIN FRICTION COEFF.             0.012766
        D R A G   B R E A K D O W N          IN  SQFT
           FEW           WING FE                                    0.0
           FEF           FUSELAGE FE                               16.493
           FEFP          FORWARD(MAIN) ROTOR PYLON FE               0.0
           FEAP          AFT ROTOR PYLON FE                         0.0
           FEMRH         MAIN ROTOR HUB(S) FE                       0.0
           FETRH         TAIL ROTOR HUB FE                          0.0
           FEVT          VERTICAL TAIL FE                           0.0
           FEHT          HORIZONTAL TAIL FE                         0.0
           FEN           PRIMARY ENGINE NACELLE FE                  0.0
           FENI          AUX. INDEPENDENT CRUISE ENG. NAC. FE       0.0
           FENS          AUX. INDEPENDENT CRUISE ENG. STRUT FE      0.0
           DELTA FE      INCREMENTAL FE                             0.0
A E R O D Y N A M I C   C O E F F .
           A5                                              16.45284
           A6                                               0.0
           A7                                               0.0
           A8                                               0.0
           A9                                               0.24095
           E       WING LIFT EFFICIENCY FACTOR            0.0
           EVT     VERTICAL TAIL LIFT EFFICIENCY FACTOR   0.88071
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   8-91

MISSION PERFORMANCE DATA

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR 0.033 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	RHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	POTLIP CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CDO
0.0	0.0	0.0	36164.	0.	0.0	2580.1	T	1.000	3646.	1.262	0.730	7911.	0.0230	0.180
650.0	7381.	*****	0.	342.	3646.		A		90.0	0.0	0.730	0.0	0.0	0.0
0.011	0.0	40.5	36123.	0.	0.0	2580.1	T	1.000	3646.	1.262	0.730	7897.	0.0200	0.180
650.0	7367.	*****	0.	342.	3646.		A		90.0	0.0	0.730	0.0	0.0	0.0
0.022	0.0	80.9	36083.	0.	0.0	2580.1	T	1.000	3646.	1.262	0.730	7883.	0.0199	0.180
650.0	7354.	*****	0.	342.	3646.		A		90.0	0.0	0.730	0.0	0.0	0.0
0.033	0.0	121.4	36042.	0.	0.0	2580.1	T	1.000	3646.	1.262	0.730	7869.	0.0199	0.179
650.0	7340.	*****	0.	341.	3646.		A		90.0	0.0	0.730	0.0	0.0	0.0

CLIMB TO 5000. FT. WITH   MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	RFP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. BHP OR THRUST	
CPPRO	CPIND	CPPAR	CPMUD	CDO	DELCDS	DELCDP	CXR	POTLIP CODE	J	CP	CT	CLW	CDW	RN	
0.033	0.0	121.4	36042.	0.	95.1	2580.0	T	1.000	95.1	0.256	0.135	-0.6	30.3	9531.	5692.
650.0	1943.	*****	0.	----	4230.	56.	0.850	0.330	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.00154	A	----	----	----	----	----	----	
0.035	0.14	127.6	36036.	500.	95.1	2580.	T	1.000	94.4	0.25[illegible]	0.137	-0.6	29.9	9437.	56[illegible]1.
650.0	1969.	*****	0.	----	4182.	56.	0.850	0.309	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.00154	A	----	----	----	----	----	----	

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PCHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	PHP	
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	PHP AUX	ETAF PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PCHF		AUX. ENG. RHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CKR	POTLIM CODE	J	CP	CT	CLW	CLW	FN	
0.036	0.28	133.8	36030.	1000.	96.1	2580.0	T	1.000	94.7	0.252	0.139	-0.6	29.2	9346.	5519.
650.0	1959.	*****	0.	----	4135.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000157	A	----	----	----	----	----	----	
0.038	0.43	140.1	36024.	1500.	97.1	2580.0	T	1.000	95.0	0.255	0.141	-0.6	28.6	9255.	5415.
650.0	2038.	*****	0.	----	4069.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000160	A	----	----	----	----	----	----	
0.039	0.58	146.4	36017.	2000.	97.1	2580.0	T	1.000	94.3	0.255	0.143	-0.6	28.1	9161.	5320.
650.0	2061.	*****	0.	----	4041.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000160	A	----	----	----	----	----	----	
0.041	0.74	152.7	36011.	2500.	98.1	2580.0	T	1.000	94.6	0.257	0.145	-0.6	27.5	9070.	5223.
650.0	2097.	*****	0.	----	3995.	58.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000163	A	----	----	----	----	----	----	
0.042	0.89	159.1	36005.	3000.	98.1	2580.0	T	1.000	93.9	0.257	0.147	-0.6	27.0	8976.	5125.
650.0	2133.	*****	0.	----	3949.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000163	A	----	----	----	----	----	----	
0.044	1.06	165.5	35998.	3500.	99.1	2580.0	T	1.000	94.1	0.260	0.149	-0.6	26.3	8885.	5024.
650.0	2175.	*****	0.	----	3901.	58.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000167	A	----	----	----	----	----	----	
0.046	1.22	172.8	35992.	4000.	100.1	2580.0	T	1.000	94.4	0.263	0.151	-0.6	25.7	8796.	4922.
650.0	2219.	*****	0.	----	3855.	58.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000170	A	----	----	----	----	----	----	
0.047	1.39	178.5	35985.	4500.	101.1	2580.0	T	1.000	94.6	0.265	0.154	-0.6	25.0	8710.	482[illegible]
650.0	2266.	*****	0.	----	3809.	59.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000174	A	----	----	----	----	----	----	
0.049	1.57	185.1	35979.	5000.	102.1	2580.0	T	1.000	94.8	0.268	0.156	-0.6	24.3	8624.	4715.
650.0	2317.	*****	0.	----	3763.	60.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000177	A	----	----	----	----	----	----	

CRUISE AT 160.0 KNOTS TAS, LIMITED BY NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PCHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	PHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	PHP AUX	ETAF PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PCHF		AUX. ENG. RHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CKR	POTLIM CODE	J	CP	CT	CLW	CLW	FN
0.049	1.57	185.1	35979.	5000.	160.0	2157.0	P	0.525	167.1	0.467	0.155	0.0	.07840	4656.
650.0	3196.	*****	0.	----	2296.	1365.	0.663	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.	A	----	----	----	----	----	----
0.133	16.57	376.4	35787.	5000.	160.0	2154.1	P	0.525	167.1	.467	0.155	0.0	.07880	4619.

650.0	3159.	*****	0.	----	2283.	1365.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.216	31.57	566.7	35597.	5000.	[illegible]	2155.8	P	0.521	167.1	0.467	0.154	0.0	.07927	4582.
650.0	3124.	*****	0.	----	2271.	1365.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.299	46.57	755.5	35430.	5000.	[illegible]	2147.5	P	0.517	167.1	0.467	0.153	0.0	[illegible]	4546.
650.0	3089.	*****	0.	----	2258.	1365.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.382	61.57	944.1	35273.	5000.	[illegible]	2144.3	P	0.513	167.1	0.467	0.152	0.0	[illegible]	4511.
650.0	3054.	*****	0.	----	2247.	1365.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.457	75.00	1111.7	35152.	5000.	[illegible]	2141.6	P	0.509	167.1	0.467	0.151	0.0	[illegible]	4481.
650.0	3024.	*****	0.	----	2230.	1365.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 2000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.457	75.00	1111.7	35152.	5000.
0.457	75.00	1111.7	35152.	2000.

CRUISE AT NORMAL ENGINE RATING

TIME (HRS) / M.ROTOR VTIP (FPS) / CPPRO	RANGE (N.M.) / M.ROTOR RHP / CPIND	FUEL USED (LBS) / T.ROTOR VTIP (FPS) / CPFAR	WEIGHT (LBS.) / T.ROTOR RHP / CPNUC	PRES. ALT. (FT) / PROP VTIP (FPS) / CDP	TAS (KTS) / PRIM.ENG FUEL FLOW (LBS/HR) / DELCDS	PRIM. TURB. TEMP. (R) / RHP AUX / DELCDM	PRIM. ENG. CODE / ETAP PROP / CXR	PRIM. ENG. PEHF / TAUX/T / POTLIM CODE	EAS (KTS) / AUX. ENG. FUEL FLOW (LBS/HR) / J	KU / AUX. TURB. TEMP. / CP	CT PRIME OVER SIGMA / AUX. ENG. CODE / CT	ALPHA D/L (DEG) / AUX. ENG. PEHF / CLU	SPEC. RANGE (NMPP) / CDU	RHP / AUX. ENG. SHP OR THRUST / HA
0.457	75.00	1111.7	35152.	2000.	[illegible]	[illegible]	T	[illegible]	241.8	.721	0.172	[illegible]	[illegible]	[illegible]
583.1	[illegible]	*****	0.	----	[illegible]	[illegible]	0.714	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.517	90.00	1342.8	34821.	2000.	[illegible]	[illegible]	T	0.918	[illegible]	0.725	0.171	[illegible]	[illegible]	[illegible]
583.1	5037.	*****	0.	----	[illegible]	3621.	.714	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.577	105.00	1572.8	34591.	2000.	[illegible]	[illegible]	T	0.918	244.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
583.1	[illegible]	*****	0.	----	[illegible]	3674.	.715	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.637	120.00	[illegible]	34362.	2000.	[illegible]	[illegible]	T	[illegible]	[illegible]	.732	[illegible]	[illegible]	[illegible]	[illegible]
583.1	4941.	*****	0.	----	3841.	3725.	0.715	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----

3.696	135.(J	2129.6	34134.	2...	254.?	25...	T	0.918	246.6	.735	0.167	0.0	.06612	5802.
583.1	4896.	*****	0.	----	3642.	3775.	.716	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0..	A	----	----	----	----	----	----
0.755	150.00	2256.5	33907.	2000.	255.2	25...	T	0.916	247.8	.739	0.166	0..	0.6639	5816.
583.1	4853.	*****	0.	----	3643.	3824.	.716	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0..	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 1 ..0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.755	150.00	2256.5	33907.	2000.
0.755	150.00	2256.5	33907.	1...

LOITER FOR 0.500 HRS.

TIME (HRS) M.ROTOR VTIP (FPS) CPPRC	RANGE (N.M.) M.ROTOR EHP CPIND	FUEL USED (LBS) T.ROTOR VTIP (FPS) CPPAR	WEIGHT (LBS.) T.ROTOR RHP CPNUD	PRES. ALT. (FT) PROP VTIP (FPS) CDP	TAS (KTS) PRIM.ENG FUEL FLOW (LBS/HR) CFLCDS	PRIM. TURB. TEMP. (R) RHF AUX CFLCOM	PRIM. ENG. CODE ETAP PROP CXR	PRIM. ENG. PCHF TAUX/T ROTLIM CODE	EAS (KTS) AUX. ENG. FUEL FLOW (LBS/HR) J	MU AUX. TURB. TEMP. CP	CT PRIME OVER SIGMA AUX. ENG. CODE CT	ALPHA D/L (DEG) AUX. ENG. PCHF CLV	TOTAL FUEL FLOW (LBS/HR) COW	EHP AUX. ENG. RHP OR THRUST RM
0.755	150.00	2256.5	33907.	1000.	75..	1934.7	P	0.214	74.7	.197	0.131	-.4	1546.	1892.
650.0	1790.	*****	0.	----	1546.	36.	0.635	0.330	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0..	0.0	0.00096	A	----	----	----	----	----	----
0.855	150.00	2411.1	33753.	1000.	75.8	1933.2	P	0.212	74.7	.197	0.13.	-.4	1541.	1876.
650.0	1777.	*****	0.	----	1541.	36.	0.635	0.3..	----	----	----	----		----
0.0	0.0	0..	0.0	0.0	0..	0.0	0.000096	A	----	----	----	----	----	----
0.955	150.00	2565.2	33598.	1000.	75..	1931.7	P	0.211	74.7	0.197	0.13.	-.4	1536.	1859.
650.0	1757.	*****	0.	----	1536.	36.	.635	0.33.	----	----	----	----		----
0.0	0..	0..	0..	.0	.	0..	0.00096	A	----	----	----	----	----	----
1.055	150.00	2718.8	33445.	1000.	76.6	1929.2	P	0.130	75.7	0.200	0.129	-.4	1531.	1844.
650.0	1741.	*****	.	----	1531.	36.	.635	0.3..	----	----	----	----		----
0.0	0.0	0..	0..	.0	0.	0.0	0.00096	A	----	----	----	----	----	----
1.155	150.00	2871.6	33292.	1000.	76..	1928..	P	.127	75.7	.20.	.129	-.4	1526.	1826.
650.0	1726.	*****	0.	----	1526.	36.	0.635	0.305	----	----	----	----		----
0.0	.	0..	0..	.0	.	0.0	0.00096	A	----	----	----	----	----	----
1.255	150.00	3024.4	33139.	1000.	76..	1927.7	P	.126	75.7	.20.	.129	-.4	1521.	1812.
650.0	1711.	*****	.	----	1521.	36.	.635	0.3..	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000096	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.255	150.00	3024.4	33139.	1000.
1.255	150.00	3024.4	33139.	0.

TAKEOFF, HOVER, OR LAND AT T/W = 1.060 FOR 0.250 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	SHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CDO
1.255	150.00	3024.4	33139.	0.	0.0	2345.6	P	0.673	2698.	1.060	0.746	5329.	0.0154	0.139
650.0	4879.	*****	0.	314.	2656.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.305	150.00	3159.3	33024.	0.	0.0	2342.9	P	0.669	2687.	1.060	0.746	5297.	0.0153	0.138
650.0	4849.	*****	0.	313.	2687.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.355	150.00	3293.6	32870.	0.	0.0	2340.3	P	0.665	2676.	1.060	0.746	5265.	0.0153	0.137
650.0	4819.	*****	0.	311.	2676.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.405	150.00	3427.4	32736.	0.	0.0	2337.7	P	0.661	2665.	1.060	0.746	5233.	0.0152	0.137
650.0	4789.	*****	0.	310.	2665.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.455	150.00	3560.7	32603.	0.	0.0	2335.1	P	0.657	2655.	1.060	0.746	52[illegible]1.	0.0151	0.136
650.0	4759.	*****	0.	309.	2655.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.505	150.00	3693.4	32470.	0.	0.0	2332.5	P	0.653	2644.	1.060	0.746	5174.	0.0151	0.136
650.0	4739.	*****	0.	307.	2644.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.505	150.00	3693.4	32470.	0.	0.0	2332.5	P	0.653	2644.	1.060	0.746	5174.	0.0151	0.136
650.0	4739.	*****	0.	307.	2644.	----	A		90.0	0.0	0.746	0.0	0.0	0.0

CLIMB TO 3000. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	SHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAF PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. RHP OR THRUST	
CPPRO	CPIND	CPFAR	CPNUF	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLV	CDW	RN	
1.505	150.00	3693.4	32470.	0.	91.[illegible]	258[illegible]	T	1.00[illegible]	91.[illegible]	.241	.121	-[illegible].6	35.[illegible]	5519.	6[illegible]1.

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650.0      1609.    *****       0.    ----     4227.      51.    .650  0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000143  A       ----   ----   ----   ----   ----   ----

1.506     150.67   3696.6   32467.    300.      91.9   2590.0     T   1.000   91.5  0.241  0.122   -0.6   34.6   9462. 6544.
650.0     1619.    *****       0.    ----     4198.      51.    0.650  0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000143  A       ----   ----   ----   ----   ----   ----

1.507     150.14   3699.9   32464.    600.      91.9   2581.0     T   1.000   91.1  0.241  0.123   -0.6   34.6   9406. 6491.
650.0     1627.    *****       0.    ----     4176.      51.    0.650  0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000143  A       ----   ----   ----   ----   ----   ----

1.508     150.21   3703.1   32461.    900.      91.9   2580.0     T   1.000   90.7  0.241  0.124   -0.6   34.4   9349. 6435.
650.0     1637.    *****       0.    ----     4141.      50.    0.650  0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000143  A       ----   ----   ----   ----   ----   ----

1.508     150.29   3706.3   32457.   1200.      92.0   2580.0     T   1.000   91.2  0.244  0.126   -0.6   33.8   9296. 6380.
650.0     1649.    *****       0.    ----     4114.      51.    .65    0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000147  A       ----   ----   ----   ----   ----   ----

1.509     150.36   3709.5   32454.   1500.      92.0   2580.0     T   1.000   91.6   .244  0.127   -0.6   33.6   9239. 6327.
650.0     1660.    *****       0.    ----     4085.      50.    0.850  0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000147  A       ----   ----   ----   ----   ----   ----

1.510     150.43   3712.7   32451.   1800.      93.0   2580.0     T   1.000   91.4  0.246  0.128   -0.6   33.1   9186. 6267.
650.0     1673.    *****       0.    ----     4057.      51.    .650   0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000150  A       ----   ----   ----   ----   ----   ----

1.511     150.51   3716.0   32448.   2100.      93.0   2580.0     T   1.000   91.0  0.246  0.129   -0.6   32.9   913.. 621..
650.0     1684.    *****       0.    ----     4029.      51.    0.650  0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000150  A       ----   ----   ----   ----   ----   ----

1.512     150.59   3719.2   32444.   2400.      93.0   2580.0     T   1.000   90.6  0.246  0.130   -0.6   32.6   9073. 6153.
650.0     1696.    *****       0.    ----     4001.      51.    .650   0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000150  A       ----   ----   ----   ----   ----   ----

1.512     150.66   3722.5   32441.   2700.      94.0   2580.0     T   1.000   91.2  0.249  0.131   -0.6   32.1   9.2.. 6.9..
650.0     1711.    *****       0.    ----     3973.      52.    0.650  0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000153  A       ----   ----   ----   ----   ----   ----

1.513     150.74   3725.7   32438.   3000.      94.0   2580.0     T   1.006   90.7  0.249  0.132   -0.6   31.9   8964. 6070.
650.0     1723.    *****       0.    ----     3945.      51.    0.650  0.300   ----   ----   ----   ----          ----
0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.000153  A       ----   ----   ----   ----   ----   ----
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CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF .0 KNOTS

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                                                               PRIM.    PRIM.    PRIM.                       CT PRIME
                         FUEL                PRES.             TURB.    ENG.     ENG.                        OVER      ALPHA     SPEC.
TIME       RANGE         USED      WEIGHT    ALT.     TAS      TEMP.    CODE     PERF     EAS        MU      SIGMA     D/L       RANGE         SHP
(HRS)      (N.M.)        (LBS)     (LBS.)    (FT)     (KTS)    (R)                        (KTS)                        (DEG)     (NMPP)

                                                                                                     AUX.    AUX.      AUX.                  AUX.
M.ROTOR    M.ROTOR       T.ROTOR   T.ROTOR   PROP     PRIM.ENG  RHF     ETAF              AUX. ENG.  TURB.   ENG.      ENG.                  ENG. PCT
VTIP       RHP           VTIP      RHP       VTIP     FUEL FLOW AUX     PROF     TAUX/T   FUEL FLOW  TEMP.   CODE      PERF                  OF THRUST
(FPS)                    (FPS)               (FPS)    (LBS/HR)                            (LBS/HR)

CPPRO      CPIND         CPPAR     CPNUD     CDO      DELCDS    DELCDM  CXR      ROTLIM    J         CP      CT        CLR       CDR           ..
                                                                                 CODE
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1.513	156.74	3725.7	32438.	3000.	165.3	2131.7	P	.481	181.1	.492	.132	.0	.78357	4415.
650.0	2654.	*****	0.	----	2266.	1677.	0.667	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
1.592	156.74	3905.2	32258.	3000.	169.3	2125.5	P	0.474	181.1	.492	0.131	0.0	.78384	4393.
650.0	2633.	*****	0.	----	2259.	1677.	.667	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
1.672	176.74	4084.1	32075.	3000.	169.3	2122.2	P	0.476	181.1	0.492	0.131	0.	.78411	437[illegible].
650.0	2612.	*****	0.	----	2252.	1677.	0.667	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
1.751	195.74	4262.5	31911.	3000.	168.8	2124.4	P	0.472	180.6	0.495	0.130	0.0	.78441	4336.
650.0	2589.	*****	0.	----	2235.	1664.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
1.831	215.74	4447.2	31723.	3000.	168.8	2123.1	P	0.469	180.6	0.495	0.129	0.0	.78467	43[illegible].
650.0	2568.	*****	0.	----	2271.	1664.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
1.910	235.74	4617.3	31546.	3000.	168.3	2119.2	P	0.465	180.1	0.489	.128	0.0	.78496	42[illegible].
650.0	2535.	*****	.	----	2217.	1652.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
1.967	245.74	4793.4	31370.	3000.	168.7	2116.2	P	0.463	180.1	0.489	0.128	0.0	.78522	4248.
650.0	2515.	*****	.	----	2211.	1652.	.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
2.069	255.74	4562.5	31154.	3000.	1-7.8	2115.0	P	0.455	179.6	.483	0.127	0.	.78551	42[illegible].
650.0	2488.	*****	0.	----	2197.	1639.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	.0	.0	.0	0.0	0.0	A	----	----	----	----	----	----
2.145	275.74	5145.3	31318.	3000.	187.8	2113.4	P	0.456	179.6	0.488	0.126	.	.78576	416[illegible].
650.0	2465.	*****	0.	----	2181.	1673.	.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
2.229	295.74	532[illegible].2	31043.	3000.	187.5	2111.4	P	0.454	179.6	.486	0.125	0.0	.78[illegible]	416[illegible].
650.0	2450.	*****	0.	----	2185.	1639.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	.0	0.0	0.0	.	A	----	----	----	----	----	----
2.305	3[illegible]	5486.1	30678.	3000.	187.7	21[illegible]	P	0.45[illegible]	179.2	0.486	0.125	0.0	.78[illegible]	4131.
650.0	2425.	*****	0.	----	2172.	1626.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	.	0.0	.	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO [illegible] FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
2.2[illegible]	30[illegible].60	5466.5	30[illegible]7[illegible].	[illegible]
2.3[illegible]	[illegible]	5496.[illegible]	30[illegible]78.	[illegible]

TAKEOFF, HOVER, OR LAND AT T/ = 1.0 FOR [illegible] .33 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CORR	PRIM. ENG. CEMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	E[illegible]	[illegible]	CT	[illegible]

M.ROTOR VTIP	M.ROTOR RMP	T.ROTOR VTIP (FPS)	T.ROTOR RMP	VRC RMP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CD
2.305 650.0	300.00 4215.	5486.0 *****	30676. 0.	0. 291.	0.0 2467.	2176.5 ----	P A	0.515	2467. 59.0	1.61 0.0	.747 0.747	4626. 0.0	0.134 0.0	.121 0.
2.316 650.0	300.00 4210.	5513.4 *****	30650. 0.	0. 290.	0.0 2465.	2176.0 ----	P A	0.505	2465. 59.0	1.61 0.0	0.747 0.747	4622. 0.	0.134 0.0	0.121 0.
2.327 650.0	300.00 4204.	5540.2 *****	30623. 0.	0. 290.	0.0 2463.	2175.6 ----	P A	0.504	2463. 59.0	1.61 0.0	.747 0.747	4616. 0.0	0.134 0.0	0.121 0.0
2.338 650.0	300.00 4198.	5568.1 *****	30595. 0.	0. 293.	0.0 2461.	2175.1 ----	P A	0.503	2461. 59.	1.61 0.0	0.747 0.747	461.. 0.	0.134 0.	0.121 0.

MISSION FUEL REQUIRED = 5568.09
RESERVE FUEL REQUIRED = 618.62
TOTAL FUEL REQUIRED = 6186.70

****

END OF SUCCESSFUL CASE

****

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   H-91

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

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LOC.   CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM    STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL    EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1          VALUE               CORRESPONDING TO LOC.+0001
VAL2          VALUE               CORRESPONDING TO LOC.+0002
       ETC.

  LOC.      NUM       VAL        VAL1        VAL2        VAL3        VAL4

       NOTE : IN USING AUXILIARY ENGINES : AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED
       BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

   12.5         1         2.[illegible]
WG = 0.300000E+05  WFA = 0.618952E+04  WFF = 0.61867 E+04
WG = [illegible]E+05  WFA = .312492E+04  WFF = .527823E+04
WG = 0.336762E+05  WFA = 0.465469E+04  WFF = 0.573333E+04
```

HESCOMP
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-91

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 36164. LB

FUSELAGE

LF	LENGTH(BODY+TAILBOOM)	41.3 FT.
LC	LENGTH(CABIN)	28.3 FT.
LB	LENGTH(BODY)	35.2 FT.
LTB	LENGTH(TAILBOOM)	6.1 FT.
XM	FWD. ROTOR LOCATION	14.1 FT.
WF	WIDTH	8.3 FT.
SF	WETTED AREA	861.3 SQ. FT.

WING - NO WING USED

HOR. TAIL

ARHT	ASPECT RATIO	5.500
SHT	AREA	97.7 SQ. FT.
BHT	SPAN	23.2 FT.
CBARHT	MEAN CHORD	4.2 FT.
LAMBDA H	TAPER RATIO	0.660
(T/C)HT	THICKNESS/CHORD	0.150
LTH	HOR. TAIL ARM	21.5 FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.500
SVT	AREA	29.9 SQ. FT.
BVT	SPAN	6.7 FT.
CBARVT	MEAN CHORD	4.5 FT.
LAMBDA VT	TAPER RATIO	0.500
ZTR	TAIL ROTOR(VERT.) LOCATION	0.0 FT.
ZETAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	[illegible]
(T/C)VT	THICKNESS/CHORD	0.150

MAIN ROTOR PYLON

AR	ASPECT RATIO	[illegible].21[illegible]
SFP	WETTED AREA	168.[illegible] SQ. FT.
FAFP	FRONTAL AREA	43.6 SQ. FT.
HP1	HEIGHT	3.6 FT.
CBARFP	MEAN CHORD	17.[illegible] FT.
LAMBDA FP	TAPER RATIO	[illegible].75[illegible]
(T/C)P	ROOT THICKNESS/CHORD	[illegible].8[illegible]
(T/C)T	TIP THICKNESS/CHORD	0.60[illegible]

PRIMARY ENGINE NACELLE

LN	LENGTH	0.0 FT.
DN	MEAN DIAMETER	0. FT.
SW	WETTED AREA(TOTAL FOR ALL ENGINES)	0.0 SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION)

DAR	DIAMETER	4.0 FT.
AF	ACTIVITY FACTOR PER BLADE	169.0
SIGAR	SOLIDITY	0.897
NRA	NO. OF PROPELLERS	2.
NO. BLADES	NO. OF BLADES/PROP	13.
VTIP	TIP SPEED	900. FT./SEC

MAIN ROTOR

DMR	DIAMETER	55.4 FT.
SIGMR	SOLIDITY	0.111
WG/A	DISC LOADING	15.0 LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.0
NR	NO. OF ROTORS	1.
NO. BLADES	NO. OF BLADES/ROTOR	6.
THETA	BLADE TWIST	-10.000 DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.100
VTIP	TIP SPEED	650. FT./SEC.

- NO TAIL ROTOR USED

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                                H E S C O M P
              HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    R-91


   W E I G H T S   D A T A     IN LBS

        MLF           MANEUVER LOAD FACTOR                         3.000
        ULF           ULTIMATE LOAD FACTOR                         4.500

     PROPULSION GROUP
            WMRG      TOTAL MAIN ROTOR GROUP                       6392.
        K12 WMRB          MAIN ROTOR BLADE (PER ROTOR)                2604.
        K13 WMH           MAIN ROTOR HUB (PER ROTOR)                  3788.
            WBF           BLADE FOLDING(PER ROTOR)                       0.
        K15 WAR       AUXILIARY PROPULSION ROTOR GROUP              343.
            WDS       DRIVE SYSTEM                                 4503.
        K16 WMDS          MAIN ROTOR DRIVE SYSTEM                     4165.
        K20 WTRDS         TAIL ROTOR DRIVE SYSTEM                        0.
        K17 WADS          AUXILIARY PROPULSION DRIVE SYSTEM            338.
        K18 WEE       PRIMARY ENGINES                              1570.
        K19 WEA       AUXILARY ENGINES                                0.
            WPEI      PRIMARY ENGINE INSTALLATION                   267.
            WAEI      AUXILIARY ENGINE INSTALLATION                   0.
            WFS       FUEL SYSTEM                                   495.
        DELTA WP      PROPULSION GROUP WEIGHT INCREMENT               0.
              WP   TOTAL PROPULSION GROUP WEIGHT                                   1357[illegible].

     STRUCTURES GROUP
        K8  WW        WING                                            0.
            WTG       TAIL GROUP                                    195.
        K9  WHT           HOR. TAIL                                    195.
        K14 WTR           TAIL ROTOR                                     0.
        K6  WB        FUSELAGE                                     3264.
        K7  WLG       LANDING GEAR                                 1447.
            WNG           NOSE GEAR                                    2[illegible]9.
            WMG           MAIN GEAR                                   11[illegible]7.
            WTES      TOTAL ENGINE SECTION                          276.
            WPES          PRIMARY ENGINE SECTION                       276.
            WAES          AUXILIARY ENGINE SECTION                       0.
        DELTA WST     STRUCTURE WEIGHT INCREMENT                    2[illegible]0.
             WST   TOTAL STRUCTURE WEIGHT                                          5362.

     FLIGHT CONTROLS GROUP
            WPFC      PRIMARY FLIGHT CONTROLS                      1135.
            WCC           COCKPIT CONTROLS                              76.
        K1  WRC           MAIN ROTOR CONTROLS                          4[illegible].
        K2  WSC           MAIN ROTOR SYSTEMS CONTROLS                  313.
        K3  WFW           FIXED WING CONTROLS                          181.
            WTM           TILT MECHANISM                                 0.
            WSAS          SAS                                           75.
            WAFC      AUXILIARY FLIGHT CONTROLS                     226.
        K4  WPCA          AUX. PROPULSION ROTOR CONTROLS                [illegible].
        K5  WSCA          AUX. PROPULSION ROTOR SYS. CONTROLS          126.
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WMC	MISCELLANEOUS CONTROLS	60.	
DELTA WFC	CONTROL WEIGHT INCREMENT	0.	
WFC	TOTAL CONTROL WEIGHT		1355.
WFE	WEIGHT OF FIXED EQUIPMENT		2475.
WE	WEIGHT EMPTY		22782.
WFUL	FIXED USEFUL LOAD		864.
OWE	OPERATING WEIGHT EMPTY		23646.
WPL	PAYLOAD		6328.
(WF)A	FUEL		6190.
WG	GROSS WEIGHT		36164.

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   H-91

R O T O R   D A T A

FIXED MAIN ROTOR SOLIDITY INPUT

SAMPLE CASE NO. 3 RUN 2 PAGE 6

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                                   H E S C O M P
             HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    R-91


  P R O P U L S I O N   D A T A
        PRIMARY PROPULSION CYCLE NO.    2.41?
              TURBOSHAFT ENGINE

                 2.  ENGINES

           BHP.P          MAX. STANDARD S.L. STATIC H.P.          9971.     H.P.

           ENGINE SIZED FOR CRUISE AT VC = 25?. KNOTS.
            NORMAL  POWER SETTING.  9?.7 PERCENT HOVER RPM.
           TAUX/T = 1.00?. HC =       . FT. TEMPERATURE =  ??. 0 DEG.F..
           ARE  ?.?   ENGINES INOPERATIVE.

        NO AUX. INDEPENDENT ENGINE CYCLE SELECTED


              MAIN ROTOR DRIVE SYSTEM RATING          1?17?.     H.P.

        XMSN SIZED AT 1??. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
        (MAX. STANDARD S.L. STATIC H.P.).  ??.7 PERCENT HOVER RPM

              AUXILIARY PROPULSION DRIVE SYSTEM RATING          45?7.     H.P.

        XMSN SIZED AT  4?. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
        (MAX. STANDARD S.L. STATIC H.P.).  ??.7 PERCENT HOVER RPM
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                              H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    8-91

  A E R O D Y N A M I C S   D A T A
         FE            TOTAL EFFECTIVE FLATPLATE AREA           16.493       SQFT
         SWET          TOTAL WETTED AREA                         1292.       SQFT
         CBARF         MEAN SKIN FRICTION COEFF.              0.012766
      D R A G   B R E A K D O W N          IN  SQFT
         FEW           WING FE                                          0.0
         FEF           FUSELAGE FE                                   16.493
         FEFP          FORWARD(MAIN) ROTOR PYLON FE                     0.0
         FEAP          AFT ROTOR PYLON FE                               0.0
         FEMRH         MAIN ROTOR HUB(S) FE                             0.0
         FETRH         TAIL ROTOR HUB FE                                0.0
         FEVT          VERTICAL TAIL FE                                 0.0
         FEHT          HORIZONTAL TAIL FE                               0.0
         FEN           PRIMARY ENGINE NACELLE FE                        0.0
         FENI          AUX. INDEPENDENT CRUISE ENG. NAC. FE             0.0
         FENS          AUX. INDEPENDENT CRUISE ENG. STRUT FE            0.0
         DELTA FE      INCREMENTAL FE                                   0.0
  A E R O D Y N A M I C   C O E F F .
         A5                                                    16.49284
         A6                                                    0.0
         A7                                                    0.0
         A8                                                    0.0
         A9                                                    0.24095
         E       WING LIFT EFFICIENCY FACTOR                 0.0
         EVT     VERTICAL TAIL LIFT EFFICIENCY FACTOR        0.88071
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

MISSION PERFORMANCE DATA

TAKEOFF, HOVER, OR LAND AT PETF = 1.0?? FOR 0.?73 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	PHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELCDM	FMI	CPPRO	CPIND	CDO
0.0	.0	0.0	36164.	0.	0.0	2566.1	T	1.000	3646.	1.262	0.730	7911.	0.0296	0.116
650.0	7361.	*****	0.	342.	3646.		A		90.0	0.0	.73	.0	0.0	.
0.011	0.0	40.5	36123.	0.	0.	2566.1	T	1.000	3646.	1.262	.73	7697.	.02	.11
650.0	7367.	*****	0.	342.	3646.		A		90.0	0.0	0.730	0.0	.0	.0
0.022	0.0	80.9	36083.	0.	0.0	2560.1	T	1.000	3646.	1.262	0.730	7683.	0.0196	0.116
650.0	7354.	*****	0.	342.	3646.		A		90.0	0.0	.73	.0	.0	.
0.033	0.0	121.4	36042.	0.	0.	2560.1	T	1.000	3646.	1.262	.73	7669.	.0195	0.179
650.0	7342.	*****	.	341.	3646.		A		90.0	0.0	0.730	0.0	0.0	.0

CLIMB TO ????. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	PHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	PHP AUX	STAB PROF	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. SHP OR THRUST	
CPPRO	CPIND	CPPAR	CPMUD	CDO	DELCDS	DELCDM	CXS	ROTLIM CODE	J	CP	CT	CLS	CDW	PN	
0.033	0.0	121.4	36142.	0.	55.1	2581.	T	1.0??	95.1	.25	.17	-.?	?.?	9?31.	[illegible]
650.0	1643.	*****	0.	----	4231.	56.	.85	.3?	----	----	----	----		----	
0.0	0.0	0.0	0.1	.0	0.	0.0	0.00154	A	----	----	----	----	----	----	
0.035	0.14	127.6	36036.	501.	55.1	2580.	T	1.060	94.4	0.259	0.137	-0.?	27.9	9437.	[illegible]
650.0	1969.	*****	.	----	4142.	56.	.85	0.3??	----	----	----	----		----	
0.0	0.0	0.0	.0	.0	0.?	0.0	0.00154	A	----	----	----	----	----	----	

```
0.036      0.24   133.6   36030.   1560.     56.1   2560.0      T     1.000    54.7   .252   .139   -6.6   25.2   9346. 5534.
650.0     1999.   *****      0.    ----     4135.      57.   .850   0.3
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000157    A       ----   ----   ----   ----   ----   ----

0.038      0.43   140.1   36024.   1500.     57.1   2580.0      T     1.000    55.0   0.255  0.141  -6.6   25.6   9255. 5415.
650.0     2030.   *****      0.    ----     4 89.      57.   .851   0.3
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000166    A       ----   ----   ----   ----   ----   ----

0.039      0.64   146.4   36017.   2000.     57.1   2560.0      T     1.000    54.3   0.255  0.143  -6.6   27.1   9161. 532 .
650.0     2261.   *****      0.    ----     4141.      57.   .850   0.3
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000163    A       ----   ----   ----   ----   ----   ----

0.041      0.74   152.7   36011.   2500.     58.1   2560.0      T     1.000    54.6   0.257  0.145  -6.6   27.5   5175. 5243.
650.0     2257.   *****      0.    ----     3995.      58.   .851   0.300
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000163    A       ----   ----   ----   ----   ----   ----

0.042      0.89   159.1   36005.   3000.     58.1   2560.      T     1.000    57.9   .257   0.147  -6.6   27.    8976. 5115.
650.0     2133.   *****      0.    ----     3584.      57.   0.850  0.300
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000163    A       ----   ----   ----   ----   ----   ----

0.044      1.06   165.5   35996.   3500.     59.1   2560.0      T     1.000    94.1   0.26   0.149  -6.6   26.8   6685. 5124.
650.0     2175.   *****      .    ----     4001.      58.   0.850  0.300
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000167    A       ----   ----   ----   ----   ----   ----

0.046      1.22   172.0   35992.   4000.    105.1   2560.0      T     1.000    94.4   0.263  0.151  -6.6   21.7   8796. 4902.
650.0     2215.   *****      0.    ----     7655.      58.   0.850  0.3.0
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000170    A       ----   ----   ----   ----   ----   ----

0.047      1.39   17 .5   35985.   4500.    111.1   2560.0      T     1.000    94.6   0.265  .154   -6.6   21.    871 . 461 .
650.0     2266.   *****      0.    ----     7500.      55.   0.850  0.350
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000174    A       ----   ----   ----   ----   ----   ----

0.049      1.57   185.1   35978.   5000.    112.1   2560.0      T     1.000    94.6   .266   .156   -6.6   24.3   6124. 4715.
650.0     2317.   *****      .    ----     7763.      60.   0.850  0.3
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.000177    A       ----   ----   ----   ----   ----   ----

CRUISE AT   165.0  KNOTS TAS, LIMITED BY  NORMAL   ENGINE RATING

                                                   PRIM.   PRIM.    PRIM.                  CT PRIM   ALPHA   SPEC.
                    FUEL                PRES.      TURB.   ENG.     ENG.                   CVER      P/L     RANGE
TIME     RANGE      USED     WEIGHT     ALT.   TAS TEMP.   CODE     CSHP   EAS     MU      SIGMA     (DEG)   (N.MPP)    CHP
(HRS)    (N.M.)     (LBS)    (LBS.)     (FT)  (KTS) (R)                    (KTS)

                                                                                   AUX.    AUX.      AUX.                AUX.
M.ROTOR  M.ROTOR  T.ROTOR   T.ROTOR     PROP  PRIM.ENG  PHP  STAB         AUX. ENG. TURB.  ENG.      ENG.                ENG. HHP
VTIP     EHP      VTIP      EHP         VTIP  FUEL FLOW AUX  PROP TAUX/T  FUEL FLOW TEMP.  CODE      CSHP                OR THRUST
(FPS)             (FPS)                 (FPS) (LBS/HR)                    (LBS/HR)

CPPRS    CPIND    CPPAR     CPMUD       CDO   FELCDS    FELCDM  CXF  ROTLIM   J     CP      CT        FLW    CPU         CW
                                                                        CODE

0.049      1.57   185.1   35978.   5000.    165.   2157.6      P     0.529   367.1  .417   .155    .     . 714        4655.
650.0     3196.   *****      .    ----     2296.    1365.   .643  1.000    ----   ----   ----   ----               ----
0.0     0.0    0.0      0.0    0.0      0.0     0.0    0.                A       ----   ----   ----   ----   ----   ----

0.132     16.57   376.4   35707.   5000.    165.0   2154.1      P     0.525   367.1  0.467  .155    .     . 714        4631.
```

650.[illegible]	3159.	*****	[illegible]	----	2283.	1365.	[illegible].683	1.000	----	----	----	----		----
0.0	0.0	0.0	[illegible]	.0	[illegible]	0.0	0.[illegible]	A	----	----	----	----	----	----
0.216	31.57	566.7	35597.	5[illegible].	1[illegible].	2150.[illegible]	P	[illegible].521	167.1	.467	[illegible].154	[illegible]	.7927	4582.
650.[illegible]	3124.	*****	0.	----	2271.	1365.	0.683	1.000	----	----	----	----		----
0.0	[illegible]	[illegible]	0.0	[illegible].0	[illegible]	0.0	0.[illegible]	A	----	----	----	----	----	----
0.299	46.57	755.9	354[illegible].	5[illegible].	1[illegible]	2147.5	P	[illegible].517	167.1	[illegible].467	[illegible].153	[illegible]	.7[illegible]	4546.
650.[illegible]	3[illegible].	*****	.	----	2258.	1365.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	[illegible].0	0.0	0.0	0.[illegible]	A	----	----	----	----	----	----
0.383	61.57	944.1	35223.	5[illegible].	169.	2144.3	P	[illegible].517	167.1	[illegible].467	[illegible].152	[illegible]	.[illegible]12	4511.
650.[illegible]	3[illegible]54.	*****	[illegible].	----	2247.	1365.	[illegible].683	1.[illegible]	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.[illegible]	0.0	0.[illegible]	A	----	----	----	----	----	----
0.457	75.00	1111.7	35052.	5000.	16[illegible]	2141.6	P	0.509	167.1	.467	[illegible].151	[illegible]	.[illegible]	4461.
650.[illegible]	3[illegible]24.	*****	[illegible].	----	2236.	1365.	[illegible].683	1.00[illegible]	----	----	----	----		----
0.0	[illegible]	[illegible]	[illegible]	[illegible].0	[illegible]	[illegible]	0.[illegible]	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 2[illegible]. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.457	75.00	1111.7	35[illegible]52.	5000.
0.457	75.00	1111.7	35052.	2000.

CRUISE AT NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PERF	EAS (KTS)	MU	CT FRIMP OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (N/PP)	RHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LPS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PERF		AUX. ENG. RHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUP	CDO	DELCDS	DELCDP	CXP	ROTLIM CODE	J	CP	CT	CLR	CDR	CF
0.457	75.0[illegible]	1111.7	35[illegible]52.	2[illegible].	2[illegible].	[illegible]	T	[illegible].91[illegible]	241.[illegible]	0.721	0.17[illegible]	[illegible].0	.[illegible]0495	87[illegible].
583.1	[illegible]27.	*****	.	----	3[illegible].	3[illegible]67.	[illegible].714	1.0[illegible]	----	----	----	----		----
0.0	0.0	[illegible]	[illegible]	.0	[illegible]	[illegible]	.	A	----	----	----	----	----	----
0.517	[illegible]	1342.[illegible]	34321.	2[illegible].	2[illegible]	[illegible]	T	[illegible].91[illegible]	243.[illegible]	.72[illegible]	[illegible].171	[illegible]	.[illegible]502	8751.
583.1	[illegible]37.	*****	[illegible]	----	3[illegible].	3621.	[illegible].714	1.00[illegible]	----	----	----	----		----
0.0	[illegible]	[illegible]	[illegible]	[illegible].0	[illegible]	[illegible]	[illegible]	A	----	----	----	----	----	----
0.577	1[illegible]5.00	1572.8	34591.	2[illegible].	[illegible]1.[illegible]	25[illegible]	T	.91[illegible]	244.3	.72[illegible]	.17	.	.[illegible]	[illegible]794.
583.1	49[illegible].	*****	[illegible].	----	3839.	3674.	[illegible].715	1.00[illegible]	----	----	----	----		----
0.0	0.0	0.0	0.0	[illegible].0	0.[illegible]	0.0	0.[illegible]	A	----	----	----	----	----	----
0.637	120.00	1[illegible]1.7	34362.	2[illegible].	252.[illegible]	[illegible]	T	[illegible].918	245.[illegible]	.732	[illegible].169	[illegible]	.6[illegible]	[illegible]79[illegible].
583.1	4941.	*****	[illegible].	----	3[illegible]41.	3725.	.715	1.[illegible]	----	----	----	----		----
0.0	[illegible]	[illegible]	0.0	.0	[illegible]	0.0	0.[illegible]	A	----	----	----	----	----	----

0.696	135.00	2029.6	34134.	2080.	254.0	2500.0	T	0.918	246.6	0.735	0.167	0.0	.06612	8802.
583.1	4896.	*****	0.	----	3842.	3775.	0.716	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.755	150.00	2256.5	33907.	2000.	255.2	2500.0	T	0.918	247.8	0.739	0.166	0.0	.06639	8806.
583.1	4853.	*****	0.	----	3843.	3824.	0.716	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.755	150.00	2256.5	33907.	2000.
0.755	150.00	2256.5	33907.	1000.

LOITER FOR 0.500 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	BHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
0.755	150.00	2256.5	33907.	1000.	75.8	1934.7	P	0.204	74.7	0.197	0.131	-0.4	1546.	1892.
650.0	1798.	*****	0.	----	1546.	36.	0.635	0.303	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000096	A	----	----	----	----	----	----
0.855	150.00	2411.1	33753.	1000.	75.8	1933.2	P	0.202	74.7	0.197	0.130	-0.4	1541.	1876.
650.0	1773.	*****	0.	----	1541.	36.	0.635	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000096	A	----	----	----	----	----	----
0.955	150.00	2565.2	33598.	1000.	75.8	1931.7	P	0.201	74.7	0.197	0.130	-0.4	1536.	1859.
650.0	1757.	*****	0.	----	1536.	36.	0.635	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000096	A	----	----	----	----	----	----
1.055	150.00	2718.8	33445.	1000.	76.8	1930.2	P	0.199	75.7	0.200	0.129	-0.4	1531.	1844.
650.0	1741.	*****	0.	----	1531.	38.	0.635	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000098	A	----	----	----	----	----	----
1.155	150.00	2871.8	33292.	1000.	76.8	1928.8	P	0.197	75.7	0.200	0.129	-0.4	1526.	1828.
650.0	1726.	*****	0.	----	1526.	38.	0.635	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000098	A	----	----	----	----	----	----
1.255	150.00	3024.4	33139.	1000.	76.8	1927.3	P	0.196	75.7	0.200	0.128	-0.4	1521.	1812.
650.0	1710.	*****	0.	----	1521.	38.	0.635	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000096	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.255	150.00	3024.4	33139.	1000.
1.255	150.00	3024.4	33139.	0.

TAKEOFF, HOVER, OR LAND AT T/W = 1.060 FOR 0.250 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	BHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CDO
1.255	150.00	3024.4	33139.	0.	0.0	2345.6	P	0.673	2698.	1.060	0.746	5329.	0.0154	0.139
650.0	4879.	*****	0.	314.	2698.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.305	150.00	3159.3	33004.	0.	0.0	2342.9	P	0.669	2687.	1.060	0.746	5297.	0.0153	0.138
650.0	4849.	*****	0.	313.	2687.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.355	150.00	3293.6	32870.	0.	0.0	2340.3	P	0.665	2676.	1.060	0.746	5265.	0.0153	0.137
650.0	4819.	*****	0.	311.	2676.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.405	150.00	3427.4	32736.	0.	0.0	2337.7	P	0.661	2665.	1.060	0.746	5233.	0.0152	0.137
650.0	4789.	*****	0.	310.	2665.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.455	150.00	3560.7	32603.	0.	0.0	2335.1	P	0.657	2655.	1.060	0.746	5201.	0.0151	0.136
650.0	4759.	*****	0.	309.	2655.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.505	150.00	3693.4	32470.	0.	0.0	2332.5	P	0.653	2644.	1.060	0.746	5170.	0.0151	0.136
650.0	4730.	*****	0.	307.	2644.	----	A		90.0	0.0	0.746	0.0	0.0	0.0
1.505	150.00	3693.4	32470.	0.	0.0	2332.5	P	0.653	2644.	1.060	0.746	5170.	0.0151	0.136
650.0	4730.	*****	0.	307.	2644.	----	A		90.0	0.0	0.746	0.0	0.0	0.0

CLIMB TO 3000. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND FAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	FAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA O/L (DEG)	GAMMA (DEG)	BHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	CDO	DFLCDS	DFLCDP	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN	
1.506	150.00	3693.4	32470.	0.	91.9	2580.	T	1.000	91.9	.241	1.121	[illegible]	35.0	9519.	66 1.

650.0	1609.	*****	0.	----	4227.	51.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000143	A	----	----	----	----	----	----
1.506	150.07	3696.6	32467.	300.	91.9	2580.0	T	1.000	91.5	0.241	0.122	-0.6	34.8	9462. 6546.
650.0	1618.	*****	0.	----	4198.	50.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000143	A	----	----	----	----	----	----
1.507	150.14	3699.9	32464.	600.	91.9	2580.0	T	1.000	91.1	0.241	0.123	-0.6	34.6	9406. 6491.
650.0	1627.	*****	0.	----	4170.	50.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000143	A	----	----	----	----	----	----
1.508	150.21	3703.1	32461.	900.	91.9	2580.0	T	1.000	90.7	0.244	0.124	-0.6	34.4	9349. 6435.
650.0	1637.	*****	0.	----	4141.	50.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000143	A	----	----	----	----	----	----
1.508	150.29	3706.3	32457.	1200.	92.9	2580.0	T	1.000	91.2	0.244	0.126	-0.6	33.8	9296. 6380.
650.0	1649.	*****	0.	----	4114.	51.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000147	A	----	----	----	----	----	----
1.509	150.36	3709.5	32454.	1500.	92.9	2580.0	T	1.000	90.8	0.244	0.127	-0.6	33.6	9239. 6323.
650.0	1660.	*****	0.	----	4085.	50.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000147	A	----	----	----	----	----	----
1.510	150.43	3712.7	32451.	1800.	93.9	2580.0	T	1.000	91.4	0.246	0.128	-0.6	33.1	9186. 6267.
650.0	1673.	*****	0.	----	4057.	51.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000150	A	----	----	----	----	----	----
1.511	150.51	3716.0	32448.	2100.	93.9	2580.0	T	1.000	91.6	0.246	0.129	-0.6	32.9	9130. 6210.
650.0	1684.	*****	0.	----	4029.	51.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000150	A	----	----	----	----	----	----
1.512	150.59	3719.2	32444.	2400.	93.9	2580.0	T	1.000	90.6	0.246	0.130	-0.6	32.6	9073. 6153.
650.0	1696.	*****	0.	----	4001.	51.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000150	A	----	----	----	----	----	----
1.512	150.66	3722.5	32441.	2700.	94.9	2580.0	T	1.000	91.2	0.249	0.131	-0.6	32.1	9020. 6095.
650.0	1711.	*****	0.	----	3973.	52.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000153	A	----	----	----	----	----	----
1.513	150.74	3725.7	32438.	3000.	94.9	2580.0	T	1.000	90.7	0.249	0.132	-0.6	31.9	8964. 6038.
650.0	1723.	*****	0.	----	3945.	51.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000153	A	----	----	----	----	----	----

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (F)	PRIM. ENG. CODF	PRIM. ENG. PCHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA O/L (DEG	SPEC. RANGE (NMPP)	RHP
N.ROTOR VTIP (FPS)	N.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODF	AUX. ENG. PCHF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPHUD	CDO	DELCDS	DELCDP	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RW

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1.513     156.74   3725.7    32438.   3000.     189.7   2131.7     P      0.481  181.1   0.492   0.132    0.0    .09357     4415.
650.0      2654.   *****        0.    ----     2266.    1677.    .687   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

1.592     165.74   3905.2    32256.   3000.     189.3   2129.9     P      0.478  181.1   0.492   0.131    0.0    .08764     4394.
650.0      2633.   *****        0.    ----     2255.    1677.   0.687   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

1.672     180.74   4084.1    32079.   3000.     189.3   2126.2     P      .476   181.1   .492    0.130    0.0    .08411     4372.
650.0      2612.   *****        0.    ----     2252.    1677.   0.687   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

1.751     195.74   4262.6    31901.   3000.     188.6   2124.8     P      0.472  180.6   .491    0.130    0.0    .08441     4330.
650.0      2583.   *****        0.    ----     2236.    1664.   0.666   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

1.830     210.74   4440.2    31723.   3000.     188.6   2123.1     P      .465   180.6   .49     0.129    0.0    .08467     4300.
650.0      2563.   *****        0.    ----     2231.    1664.    .666   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

1.910     225.74   4617.3    31546.   3000.     188.3   2118.8     P      0.465  180.1   .488    0.128     .     .08496     4266.
650.0      2535.   *****        0.    ----     2217.    1652.    .666   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

1.989     240.74   4793.8    31370.   3000.     186.3   2115.2     P      0.462  180.1   0.488   0.128    0.0    .08504     4241.
650.0      2515.   *****        0.    ----     2211.    1652.    .666   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

2.069     255.74   4969.8    31194.   3000.     187.6   2115.0     P      0.458  179.6   0.486   0.127    0.0    .08551     4211.
650.0      2498.   *****        0.    ----     2197.    1639.    .666   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

2.149     270.74   5145.3    31018.   3000.     187.6   2113.4     P      0.456  179.6   .488    0.126    0.0    .08576     4198.
650.0      2469.   *****        0.    ----     2191.    1639.   0.666   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

2.229     285.74   5320.2    31843.   3000.     187.8   2111.0     P      .454   179.6   .486    0.125    0.0    .08600     4163.
650.0      2450.   *****        0.    ----     2185.    1639.   0.686   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

2.305     300.00   5486.0    30678.   3000.     187.7   2108.8     P      0.451  179.2   .486    0.125     .     .08628     4141.
650.0      2425.   *****        0.    ----     2172.    1626.    .666   1.000   ----    ----    ----    ----                ----
0.0      0.0      0.0       0.0      0.0     0.0      0.0     0.0       A     ----    ----    ----    ----     ----       ----

TRANSFER ALTITUDE TO        1. FT.

                     FUEL                  PRES.
  TIME      RANGE    USED       WEIGHT     ALT.
  (HRS)     (N.M.)   (LBS)      (LBS.)     (FT)
  2.305     300.00   5486.0     30678.     3000.
  2.305     300.00   5486.0     30678.        0.

TAKEOFF, POWER, OR LAND AT  T/W = 1.06  FOR  0.133 HRS.

                                                     PRIM.    PRIM.   PRIM.   TOTAL      THRUST
                    FUEL                PRES.        TURB.    ENG.    ENG.    FUEL        TO
TIME      RANGE     USED      WEIGHT    ALT.    TAS  TEMP.    CODE    PERF    FLOW       WEIGHT    CL      CDF      CT     STATION
(HRS)     (N.M.)    (LBS)     (LBS.)    (FT)   (KTS) (R)                      (LBS/HR)
```

M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR PHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CD
2.305	300.00	5486.0	30678.	0.	0.0	2176.5	P	0.505	2467.	1.060	0.747	4628.	0.0134	0.121
650.0	4215.	*****	0.	291.	2467.	----	A		59.0	0.0	0.747	0.0	0.0	0.
2.316	300.00	5513.4	30650.	0.	0.0	2176.0	P	0.505	2465.	1.060	0.747	4622.	0.0134	0.121
650.0	4210.	*****	0.	290.	2465.	----	A		59.0	0.0	0.747	0.	0.0	0.0
2.327	300.00	5540.8	30623.	0.	0.0	2175.6	P	0.504	2463.	1.060	0.747	4616.	0.0134	0.121
650.0	4204.	*****	0.	290.	2463.	----	A		59.0	0.0	0.747	0.0	0.0	0.
2.338	300.00	5568.1	30595.	0.	0.0	2175.1	P	0.503	2461.	1.060	0.747	4610.	0.0134	0.121
650.0	4198.	*****	0.	290.	2461.	----	A		59.0	0.0	0.747	0.0	0.0	0.

MISSION FUEL REQUIRED = 5568.10
RESERVE FUEL REQUIRED = 618.62
TOTAL FUEL REQUIRED = 6186.72

****

END OF SUCCESSFUL CASE

****

SAMPLE CASE NO. 3 RUN 3 PAGE 1

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM H-91

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

```
LOC.  CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM   STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL   EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1         VALUE                 CORRESPONDING TO LOC.+001
VAL2         VALUE                 CORRESPONDING TO LOC.+002
      ETC.

 LOC.      NUM       VAL            VAL1            VAL2            VAL3            VAL4

      NOTE : IN USING AUXILIARY ENGINES : AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED
      BY PLACING A EEEE5 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

   22         1         1.6000
WF = 0.3[illegible]E+05   WFA = .6189520E+04   WFR = .61917 E+04
WF = 0.3[illegible]E+05   WFA = .5 [illegible]2395E+04   WFR = 0.5165617E+04
WF = 0.3[illegible]2352E+05   WFA = 0.5127245E+04   WFR = .51995[illegible]E+04
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SAMPLE CASE NO. 3 RUN 3 PAGE 2

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM H-91

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 30420. LB

FUSELAGE

LF	LENGTH(BODY+TAILBOOM)	39.0 FT.
LC	LENGTH(CABIN)	29.3 FT.
LB	LENGTH(BODY)	35.2 FT.
LTP	LENGTH(TAILBOOM)	3.8 FT.
XM	FWD. ROTOR LOCATION	14.1 FT.
WF	WIDTH	9.3 FT.
SF	WETTED AREA	836.4 SQ. FT.

WING - NO WING USED

HOR. TAIL

ARHT	ASPECT RATIO	5.5[illegible]
SHT	AREA	82.2 SQ. FT.
BHT	SPAN	21.3 FT.
CBARHT	MEAN CHORD	3.9 FT.
LAMBDA H	TAPER RATIO	[illegible].66[illegible]
(T/C)HT	THICKNESS/CHORD	[illegible].15
LTH	HOR. TAIL ARM	19.7 FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.5[illegible]
SVT	AREA	29.9 SQ. FT.
BVT	SPAN	6.7 FT.
CBARVT	MEAN CHORD	4.5 FT.
LAMBDA VT	TAPER RATIO	0.500
ZTR	TAIL ROTOR(VERT.) LOCATION	[illegible] FT.
ZETAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	[illegible]
(T/C)VT	THICKNESS/CHORD	0.15[illegible]

MAIN ROTOR PYLON

AR	ASPECT RATIO	[illegible].21[illegible]
SFP	WETTED AREA	1[illegible] SQ. FT.
FAFP	FRONTAL AREA	43.6 SQ. FT.
HP1	HEIGHT	3.6 FT.
CBARFP	MEAN CHORD	17.0 FT.
LAMBDA FP	TAPER RATIO	[illegible].75
(T/C)R	ROOT THICKNESS/CHORD	[illegible]
(T/C)T	TIP THICKNESS/CHORD	[illegible]

PRIMARY ENGINE NACELLE

LN	LENGTH	[illegible] FT.
DN	MEAN DIAMETER	[illegible]. FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	.[illegible] SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION)

DPP	DIAMETER	4. FT.
AF	ACTIVITY FACTOR PER BLADE	1[illegible]
SIGAP	SOLIDITY	[illegible].[illegible]97
NPA	NO. OF PROPELLERS	2.
NO. BLADES	NO. OF BLADES/PROP	13.
VTIP	TIP SPEED	[illegible]. FT./SEC

MAIN ROTOR

DMR	DIAMETER	[illegible] FT.
SIGMR	SOLIDITY	[illegible].111
WG/A	DISC LOADING	15.[illegible] LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	[illegible].G
NR	NO. OF ROTORS	1.
NO. BLADES	NO. OF BLADES/ROTOR	6.
THETA	BLADE TWIST	-1[illegible] DEG.
XC	BLADE CUTOUT/RADIUS RATIO	.1[illegible]
VTIP	TIP SPEED	[illegible]50. FT./SEC.

- NO TAIL ROTOR USED

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                                   H E S C O M P
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   W E I G H T S   D A T A     IN LBS

           MLF            MANEUVER LOAD FACTOR                    3.000
           ULF            ULTIMATE LOAD FACTOR                    4.500

        PROPULSION GROUP
              WPRG        TOTAL MAIN ROTOR GROUP                   4694.
          K12 WPRB            MAIN ROTOR BLADE (PER ROTOR)             2075.
          K13 WPH             MAIN ROTOR HUB (PER ROTOR)               2620.
              WBF             BLADE FOLDING(PER ROTOR)                   0.
          K15 WAP         AUXILIARY PROPULSION ROTOR GROUP          250.
              WDS         DRIVE SYSTEM                             2586.
          K16 WPDS            MAIN ROTOR DRIVE SYSTEM                  2407.
          K20 WTRDS           TAIL ROTOR DRIVE SYSTEM                    0.
          K17 WADS            AUXILIARY PROPULSION DRIVE SYSTEM        179.
          K18 WEP         PRIMARY ENGINES                          1367.
          K19 WEA         AUXILARY ENGINES                            0.
              WPEI        PRIMARY ENGINE INSTALLATION               232.
              WAEI        AUXILIARY ENGINE INSTALLATION               0.
              WFS         FUEL SYSTEM                               418.
          DELTA WP        PROPULSION GROUP WEIGHT INCREMENT           0.
                WP   TOTAL PROPULSION GROUP WEIGHT                                  9547.

        STRUCTURES GROUP
          K5  WW          WING                                        0.
              WTG         TAIL GROUP                                164.
          K8  WHT             HOR. TAIL                                164.
          K14 WTR             TAIL ROTOR                                 0.
          K6  WB          FUSELAGE                                 3017.
          K7  WLG         LANDING GEAR                             1217.
              WNG             NOSE GEAR                                243.
              WMG             MAIN GEAR                                973.
              WTES        TOTAL ENGINE SECTION                      276.
              WPES            PRIMARY ENGINE SECTION                   276.
              WAES            AUXILIARY ENGINE SECTION                   0.
          DELTA WST       STRUCTURE WEIGHT INCREMENT                2[illegible].
                WST  TOTAL STRUCTURE WEIGHT                                         4975.

        FLIGHT CONTROLS GROUP
              WPFC        PRIMARY FLIGHT CONTROLS                   922.
              WCC             COCKPIT CONTROLS                          71.
          K1  WRC             MAIN ROTOR CONTROLS                      374.
          K2  WSC             MAIN ROTOR SYSTEMS CONTROLS              250.
          K3  WFW             FIXED WING CONTROLS                      152.
              WTM             TILT MECHANISM                             0.
              WSAS            SAS                                       75.
              WAFC        AUXILIARY FLIGHT CONTROLS                 182.
          K4  WPCA            AUX. PROPULSION ROTOR CONTROLS            25.
          K5  WSCA            AUX. PROPULSION ROTOR SYS. CONTROLS       97.
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WMC	MISCELLANEOUS CONTROLS	63.	
DELTA WFC	CONTROL WEIGHT INCREMENT	0.	
WFC	TOTAL CONTROL WEIGHT		1104.
WFE	WEIGHT OF FIXED EQUIPMENT		2475.
WE	WEIGHT EMPTY		18001.
WFUL	FIXED USEFUL LOAD		864.
OWE	OPERATING WEIGHT EMPTY		18865.
WPL	PAYLOAD		6328.
(WF)A	FUEL		9227.
WG	GROSS WEIGHT		3 420.

H E S C O M P
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R O T O R D A T A

FIXED MAIN ROTOR SOLIDITY INPUT

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                                 H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM     8-91


P R O P U L S I O N   D A T A
          PRIMARY PROPULSION CYCLE NO.     2.415
                TURBOSHAFT ENGINE

                 2.  ENGINES

             PHP*P          MAX. STANDARD S.L. STATIC H.P.          8676.     H.P.

             ENGINE SIZED FOR CRUISE AT VC = 250. KNOTS,
              NORMAL  POWER SETTING,  89.7 PERCENT HOVER RPM,
             TAUX/T = 1.000, HC =      0. FT, TEMPERATURE =  59.00 DEG.F.,
             AND  0.0   ENGINES INOPERATIVE.

          NO AUX. INDEPENDENT ENGINE CYCLE SELECTED


                MAIN ROTOR DRIVE SYSTEM RATING           4891.     H.P.

          XMSN SIZED AT  56. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
          (MAX. STANDARD S.L. STATIC H.P.),  89.7 PERCENT HOVER RPM

                AUXILIARY PROPULSION DRIVE SYSTEM RATING          1785.     H.P.

          XMSN SIZED AT  21. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
          (MAX. STANDARD S.L. STATIC H.P.),  89.7 PERCENT HOVER RPM
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                              H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    8-91

A E R O D Y N A M I C S   D A T A
          FE           TOTAL EFFECTIVE FLATPLATE AREA          14.968     SQFT
          SWET         TOTAL WETTED AREA                        1235.      SQFT
          CDARF        MEAN SKIN FRICTION COEFF.               0.01211A
     D R A G   B R E A K D O W N          IN  SQFT
          FEW          WING FE                                    0.0
          FEF          FUSELAGE FE                               14.966
          FEFP         FORWARD(MAIN) ROTOR PYLON FE               0.0
          FEAP         AFT ROTOR PYLON FE                         0.0
          FEMRH        MAIN ROTOR HUB(S) FE                       0.0
          FETRH        TAIL ROTOR HUB FE                          0.0
          FEVT         VERTICAL TAIL FE                           0.0
          FEHT         HORIZONTAL TAIL FE                         0.0
          FEN          PRIMARY ENGINE NACELLE FE                  0.0
          FENI         AUX. INDEPENDENT CRUISE ENG. NAC. FE       0.
          FENS         AUX. INDEPENDENT CRUISE ENG. STRUT FE      0.0
          DELTA FE     INCREMENTAL FE                             0.0
A E R O D Y N A M I C   C O E F F .
          AF                                                   14.96764
          AS                                                    0.0
          AT                                                    0.0
          AP                                                    0.0
          A9                                                    0.24095
          E       WING LIFT EFFICIENCY FACTOR             0.0
          EVT     VERTICAL TAIL LIFT EFFICIENCY FACTOR    [illegible]71
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SAMPLE CASE NO. 3 RUN 3

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM 8-91

MISSION PERFORMANCE DATA

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR 0.033 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	BHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CDO
0.0	0.0	0.0	30420.	0.	0.0	2580.1	T	1.000	3173.	1.289	0.726	6685.	0.0204	0.184
650.0	6439.	*****	0.	288.	3173.		A		90.0	0.0	0.729	0.0	0.0	0.0
0.011	0.0	35.2	30385.	0.	0.0	2546.3	G	1.000	3049.	1.258	0.730	6617.	0.0199	0.179
650.0	6168.	*****	0.	288.	3049.		A		90.0	0.0	0.730	0.0	0.0	0.0
0.022	0.0	69.1	30351.	0.	0.0	2551.5	G	1.000	3068.	1.258	0.731	6605.	0.0195	0.179
650.0	6156.	*****	0.	287.	3068.		A		90.0	0.0	0.731	0.0	0.0	0.0
0.033	0.0	103.1	30317.	0.	0.0	2551.7	Q	1.000	3069.	1.256	0.731	6594.	0.0198	0.179
650.0	6145.	*****	0.	287.	3069.		A		90.0	0.0	0.731	0.0	0.0	0.0

CLIMB TO 5000. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	EHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAF FFOP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. BHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN	
0.033	0.0	103.1	30317.	0.	93.7	2306.2	0	1.000	98.7	.255	0.135	-0.7	19.0	5622.	3467.
650.0	1656.	*****	0.	----	2675.	57.	0.850	0.5	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000179	A	----	----	----	----	----	----	
0.036	0.24	109.5	30311.	500.	98.7	2308.8	0	1.000	98.0	.259	0.137	-0.7	18.9	5619.	3466.
650.0	1676.	*****	0.	----	2661.	57.	0.850	0.390	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000179	A	----	----	----	----	----	----	

0.038	0.48	115.9	30304.	1000.	98.7	2311.6	Q	1.000	97.3	0.259	0.139	-0.7	18.8	5616.	3444.
650.0	1698.	*****	0.	----	2647.	56.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000179	A	----	----	----	----	----	----	
0.041	0.72	122.3	30298.	1500.	99.7	2314.8	Q	1.000	97.5	0.262	0.141	-0.7	18.5	5617.	3421.
650.0	1725.	*****	0.	----	2535.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000183	A	----	----	----	----	----	----	
0.043	0.97	128.7	30291.	2000.	99.7	2318.0	Q	1.000	96.8	0.262	0.143	-0.7	18.4	5614.	3395.
650.0	1751.	*****	0.	----	2622.	56.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000183	A	----	----	----	----	----	----	
0.045	1.21	135.2	30285.	2500.	100.7	2321.7	Q	1.000	97.1	0.264	0.145	-0.7	18.1	5615.	3368.
650.0	1782.	*****	0.	----	2611.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000186	A	----	----	----	----	----	----	
0.048	1.46	141.6	30279.	3000.	100.7	2325.4	Q	1.000	96.3	0.264	0.147	-0.7	17.9	5611.	3339.
650.0	1811.	*****	0.	----	2598.	56.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000186	A	----	----	----	----	----	----	
0.050	1.72	148.1	30272.	3500.	101.7	2329.6	Q	1.000	96.6	0.267	0.149	-0.7	17.6	5612.	3307.
650.0	1846.	*****	0.	----	2587.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000190	A	----	----	----	----	----	----	
0.053	1.98	154.6	30266.	4000.	101.7	2333.9	Q	1.000	95.9	0.267	0.151	-0.7	17.5	5608.	3273.
650.0	1880.	*****	0.	----	2575.	56.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000190	A	----	----	----	----	----	----	
0.055	2.24	161.2	30259.	4500.	102.7	2338.8	Q	1.000	96.1	0.269	0.154	-0.7	17.1	5607.	3236.
650.0	1920.	*****	0.	----	2567.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000194	A	----	----	----	----	----	----	
0.058	2.51	167.8	30252.	5000.	103.7	2344.1	Q	1.000	96.3	0.272	0.156	-0.7	16.8	5606.	3195.
650.0	1963.	*****	0.	----	2560.	57.	0.850	0.300	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000197	A	----	----	----	----	----	----	

CRUISE AT 180.0 KNOTS TAS, LIMITED BY NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	FHP
M.ROTOR VTIP (FPS)	P.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXP	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
0.058	2.51	167.8	30252.	5000.	180.0	2153.9	P	0.626	167.1	0.467	0.155	0.0	.0964	4017.
650.0	2686.	*****	0.	----	1986.	1246.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.141	17.51	333.3	30067.	5000.	180.1	2150.5	P	0.626	167.1	0.467	0.155	0.0	.09114	3985.

650.0	2654.	*****	0.	----	1975.	1246.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.225	32.51	497.9	29922.	5000.	180.0	2147.2	P	0.626	167.1	.467	0.154	0.0	.09164	3953.
650.0	2624.	*****	0.	----	1964.	1246.	0.683	1.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.308	47.51	661.5	29759.	5500.	180.0	2144.0	P	0.626	167.1	.467	0.153	0.0	.9214	3922.
650.0	2593.	*****	0.	----	1954.	1246.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.391	62.51	824.4	29596.	5000.	180.0	2140.8	P	0.626	167.1	.467	0.152	0.0	.9262	3892.
650.0	2564.	*****	0.	----	1943.	1246.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.461	75.00	959.2	29461.	5000.	180.0	2136.7	P	0.626	167.1	.467	0.151	0.0	.093 2	3867.
650.0	2535.	*****	0.	----	1935.	1246.	0.683	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 2000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.461	75.00	959.2	29461.	5000.
0.461	75.00	959.2	29461.	2000.

CRUISE AT NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PCNT	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	RHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PCNT		AUX. ENG. PWR OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXP	ROTLIM CODE	J	CP	CT	CLW	CDW	S%
0.461	75.00	959.2	29461.	2000.	202.0	2249.0	0	1.000	196.3	0.565	0.172	0.0	.0327	5251.
583.1	3372.	*****	0.	----	2428.	1787.	0.692	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.	A	----	----	----	----	----	----
0.535	90.00	1139.4	29281.	2000.	202.3	2243.0	0	1.000	196.4	.566	0.171	0.0	.08465	5232.
583.1	3318.	*****	0.	----	2407.	1789.	0.692	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	A	----	----	----	----	----	----
0.609	105.00	1317.6	29102.	2000.	202.3	2237.2	0	1.000	196.5	.566	0.17.	0.	.0848	5151.
583.1	3267.	*****	0.	----	2386.	1791.	0.692	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.	A	----	----	----	----	----	----
0.683	120.00	1494.7	28925.	2000.	202.4	2231.7	0	1.000	196.5	0.566	0.169	0.0	.0854	51..
583.1	3218.	*****	0.	----	2366.	1792.	.692	1.000	----	----	----	----		----
0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----

0.757	135.00	1670.1	28750.	2000.	202.5	2226.4	0	1.000	196.6	0.566	0.169	0.0	.08626	5159.
583.1	3170.	*****	0.	----	2347.	1794.	0.692	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
0.831	150.00	1844.0	28576.	2000.	202.5	2221.3	0	1.000	196.7	0.586	0.167	0.0	.08697	5014.
583.1	3124.	*****	0.	----	2329.	1796.	0.692	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.831	150.00	1844.0	28576.	2000.
0.831	150.00	1844.0	28576.	1000.

LOITER FOR 0.500 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	RHP
N.ROTOR VTIP (FPS)	N.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDP	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RH
0.831	150.00	1844.0	28576.	1000.	67.8	1925.9	P	0.287	86.6	0.228	0.131	-0.6	1333.	1614.
650.0	1502.	*****	0.	----	1333.	51.	0.643	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000139	A	----	----	----	----	----	----
0.931	150.00	1977.3	28443.	1000.	67.8	1928.5	P	0.285	86.6	0.226	0.130	-0.6	1329.	1666.
650.0	1488.	*****	0.	----	1329.	51.	0.640	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000139	A	----	----	----	----	----	----
1.031	150.00	2110.2	28310.	1000.	66.6	1927.7	P	0.284	67.8	0.179	0.13[illegible]	-0.3	1324.	1572.
650.0	1487.	*****	0.	----	1324.	25.	0.631	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.000085	A	----	----	----	----	----	----
1.131	150.00	2242.6	28178.	1000.	66.6	1926.2	P	0.282	67.8	0.179	0.13[illegible]	-0.3	1319.	1559.
650.0	1473.	*****	0.	----	1319.	25.	0.631	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000085	A	----	----	----	----	----	----
1.231	150.10	2374.5	28046.	1000.	66.6	1924.6	P	0.279	67.8	0.179	0.129	-0.3	1314.	1547.
650.0	1459.	*****	0.	----	1314.	25.	0.631	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000085	A	----	----	----	----	----	----
1.331	150.00	2505.9	27914.	1000.	66.6	1923.1	P	0.276	67.8	0.179	0.128	-0.3	1310.	1525.
650.0	1445.	*****	0.	----	1310.	25.	0.631	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000085	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.331	150.00	2505.9	27914.	110.
1.331	150.00	2505.9	27914.	0.

TAKEOFF, HOVER, OR LAND AT T/W = 1.06 FOR 0.250 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PCHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	BHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCP	FMI	CPPRO	CPIND	CUO
1.331	150.00	2505.9	27914.	0.	0.0	2332.2	P	0.814	2350.	1.060	0.746	4456.	0.0154	0.139
650.0	4113.	*****	0.	264.	2350.	----	A		90.0	0.	.746	[illegible]	[illegible]	[illegible]
1.381	150.00	2620.9	27799.	0.	0.0	2329.7	P	0.818	2291.	1.060	0.746	4479.	.0152	.138
650.0	4097.	*****	0.	263.	2291.	----	A		90.0	0.	.746	[illegible]	[illegible]	[illegible]
1.431	150.00	2735.5	27685.	0.	0.0	2327.1	P	0.813	2282.	1.060	0.746	4442.	.0153	.138
650.0	4061.	*****	0.	262.	2282.	----	A		90.0	0.	.746	[illegible]	[illegible]	[illegible]
1.481	150.00	2849.6	27571.	0.	0.0	2324.5	P	0.838	2273.	1.060	0.746	4414.	.0152	.137
650.0	4036.	*****	0.	261.	2273.	----	A		90.0	0.	.746	[illegible]	[illegible]	[illegible]
1.531	150.00	2963.2	27457.	0.	0.0	2322.0	P	0.803	2264.	1.060	0.746	4388.	.0151	.136
650.0	4010.	*****	0.	260.	2264.	----	A		90.0	0.	.746	[illegible]	[illegible]	[illegible]
1.581	150.00	3076.4	27344.	0.	0.0	2319.5	P	0.798	2255.	1.060	0.746	4361.	.0151	.136
650.0	3985.	*****	0.	259.	2255.	----	A		90.0	0.	.746	[illegible]	[illegible]	[illegible]
1.581	150.00	3076.4	27344.	0.	0.0	2319.5	P	0.798	2255.	1.060	0.746	4361.	.0151	.136
650.0	3985.	*****	0.	259.	2255.	----	A		90.0	0.	.746	[illegible]	[illegible]	[illegible]

CLIMB TO 3000. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PCHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	HP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	PHF AUX	STAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PCHF		AUX. ENG. PHI OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	.COO	DELCDS	DELCDM	CXK	ROTLIM CODE	J	CP	CT	CLV	CDV	PM	
1.581	150.00	3076.4	27344.	0.	96.6	2308.8	G	1.[illegible]	56.6	.254	.121	-.7	[illegible]	5644.	4172.

650.0	1391.	*****	0.	----	2683.	54.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000172	A	----	----	----	----	----	----
1.583	150.12	3079.6	27341.	300.	96.6	2310.3	6	1.000	96.2	.254	0.122	-0.7	22.8	5643. 4164.
650.0	1388.	*****	0.	----	2675.	53.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000172	A	----	----	----	----	----	----
1.584	150.23	3082.8	27337.	600.	97.6	2312.3	6	1.000	96.6	0.256	0.123	-0.7	22.6	5646. 4157.
650.0	1395.	*****	0.	----	2668.	55.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000175	A	----	----	----	----	----	----
1.585	150.35	3086.1	27334.	900.	97.6	2314.6	6	1.000	96.4	0.256	0.125	-0.7	22.5	5645. 4149.
650.0	1407.	*****	0.	----	2660.	54.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000175	A	----	----	----	----	----	----
1.586	150.47	3089.3	27331.	1200.	97.6	2315.8	6	1.000	95.9	0.256	0.126	-0.7	22.5	5643. 4139.
650.0	1415.	*****	0.	----	2652.	54.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000175	A	----	----	----	----	----	----
1.587	150.59	3092.5	27328.	1500.	98.6	2318.0	6	1.000	96.5	0.259	0.127	-0.7	22.2	5646. 4130.
650.0	1427.	*****	0.	----	2646.	55.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000179	A	----	----	----	----	----	----
1.589	150.71	3095.7	27325.	1800.	97.6	2315.6	6	1.000	95.1	0.256	0.129	-0.7	22.4	5635. 412[illegible].
650.0	1431.	*****	0.	----	2636.	53.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000175	A	----	----	----	----	----	----
1.590	150.83	3098.8	27321.	2100.	98.6	2322.[illegible]	6	1.000	95.6	0.259	0.129	-0.7	22.1	5642. 4110.
650.0	1444.	*****	1.	----	2630.	54.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000179	A	----	----	----	----	----	----
1.591	150.95	3102.1	27318.	2400.	98.6	2324.1	6	1.000	95.2	0.258	0.130	-0.7	22.1	5640. 4100.
650.0	1453.	*****	0.	----	2622.	53.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000179	A	----	----	----	----	----	----
1.592	151.07	3105.3	27315.	2700.	98.6	2326.3	6	1.000	94.8	0.259	0.131	-0.7	22.0	5638. [illegible]
650.0	1463.	*****	0.	----	2615.	53.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000179	A	----	----	----	----	----	----
1.594	151.20	3108.5	27312.	3000.	98.6	2328.6	6	1.000	94.4	0.259	0.132	-0.7	22.0	5636. [illegible]
650.0	1472.	*****	0.	----	2607.	52.	0.850	0.300	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000179	A	----	----	----	----	----	----

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF [illegible] KNOTS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. SCHP	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	SHP
M.ROTOR VTIP (FPS)	P.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR SHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	SHP AUX	ETAP CROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. SCHP		AUX. ENG. SHP OR THRUST
CPPRO	CPIRP	CPPAR	CPNUD	CDO	DELCOS	DELCEM	CXP	ROTLIM CODE	J	CP	CT	CLW	CDW	PM

1.594	151.21	3130.5	27312.	3000.	187.3	2125.1	P	0.742	179.2	.486	0.132	0.	.9923	3767.
650.0	2257.	*****	0.	----	1947.	1495.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.	A	----	----	----	----	----	----
1.674	166.21	3264.3	27156.	3000.	187.3	2123.2	P	0.742	179.2	0.486	0.131	0.0	.99654	3746.
650.0	2189.	*****	0.	----	1941.	1485.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.	A	----	----	----	----	----	----
1.754	181.21	3419.7	27000.	3000.	186.8	2119.8	P	0.742	178.7	.486	0.131	0.0	.9689	3711.
650.0	2163.	*****	0.	----	1929.	1475.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	A	----	----	----	----	----	----
1.834	196.20	3574.5	26846.	3000.	186.8	2118.1	P	0.742	178.7	.485	.131	0.0	.9719	3697.
650.0	2146.	*****	0.	----	1923.	1475.	0.686	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
1.914	211.20	3726.9	26691.	3000.	186.3	2114.8	P	0.736	178.2	.484	0.129	0.0	.9754	3656.
650.0	2121.	*****	0.	----	1911.	1462.	0.685	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
1.995	226.20	3882.7	26535.	3000.	186.3	2113.1	P	0.736	178.2	.484	0.128	0.	.9784	3639.
650.0	2104.	*****	0.	----	1905.	1462.	0.685	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	A	----	----	----	----	----	----
2.075	241.20	4036.1	26384.	3000.	186.3	2111.5	P	0.736	178.2	0.484	0.128	0.	.9813	3622.
650.0	2087.	*****	0.	----	1899.	1462.	0.685	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.0	A	----	----	----	----	----	----
2.156	256.21	4188.6	26231.	3000.	185.8	2108.3	P	0.731	177.7	.482	0.127	0.0	.9847	[illegible]
650.0	2063.	*****	0.	----	1888.	1451.	0.685	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.	A	----	----	----	----	----	----
2.237	271.20	4341.2	26079.	3000.	185.8	2106.7	P	0.731	177.7	0.482	0.126	0.0	.9876	3565.
650.0	2047.	*****	0.	----	1882.	1451.	0.685	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.	A	----	----	----	----	----	----
2.317	286.20	4492.4	25927.	3000.	185.3	2103.6	P	0.725	177.3	0.481	0.125	0.0	.9909	3535.
650.0	2024.	*****	0.	----	1871.	1439.	0.685	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.	A	----	----	----	----	----	----
2.392	300.00	4632.3	25768.	3000.	185.3	2102.2	P	.725	177.3	0.481	0.125	0.	.9936	[illegible]
650.0	2000.	*****	0.	----	1866.	1439.	0.685	1.000	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	A	----	----	----	----	----	----

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
2.392	300.00	4632.3	25768.	3000.
2.392	300.00	4632.3	25768.	0.

TAKEOFF, HOVER, OR LAND AT T/4 = 1.060 FOR 0.033 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. RPMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FP	FHP	CT	CT/SIGMA

M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FPI	CPPRO	CPIND	CDO
2.392	388.88	4632.5	25788.	0.	0.0	2164.7	P	0.489	2104.	1.060	0.747	3894.	0.0134	0.121
650.0	3542.	*****	0.	244.	2104.	----	A		59.0	0.0	0.747	0.0	0.0	0.0
2.403	388.88	4655.7	25764.	0.	0.0	2164.3	P	0.521	2102.	1.060	0.747	3888.	0.0134	0.121
650.0	3537.	*****	0.	244.	2102.	----	A		59.0	0.0	0.747	0.0	0.0	0.0
2.414	388.88	4679.8	25741.	0.	0.0	2163.8	P	0.520	2100.	1.060	0.747	3883.	0.0134	0.121
650.0	3533.	*****	0.	244.	2100.	----	A		59.0	0.0	0.747	0.0	0.0	0.0
2.425	388.88	4702.3	25718.	0.	0.0	2163.4	P	0.519	2099.	1.060	0.747	3878.	0.0134	0.121
650.0	3528.	*****	0.	244.	2099.	----	A		59.0	0.0	0.747	0.0	0.0	0.0

MISSION FUEL REQUIRED = 4702.31
RESERVE FUEL REQUIRED = 522.43
TOTAL FUEL REQUIRED = 5224.74

****

END OF SUCCESSFUL CASE

****

7.3.4 Coaxial Rotor Helicopter With Auxiliary Propulsion

The design mission profile is illustrated in Figure 7-4. The engine and rotor cycles are not discussed in this case. A complete copy of the program printout follows the description of the input.

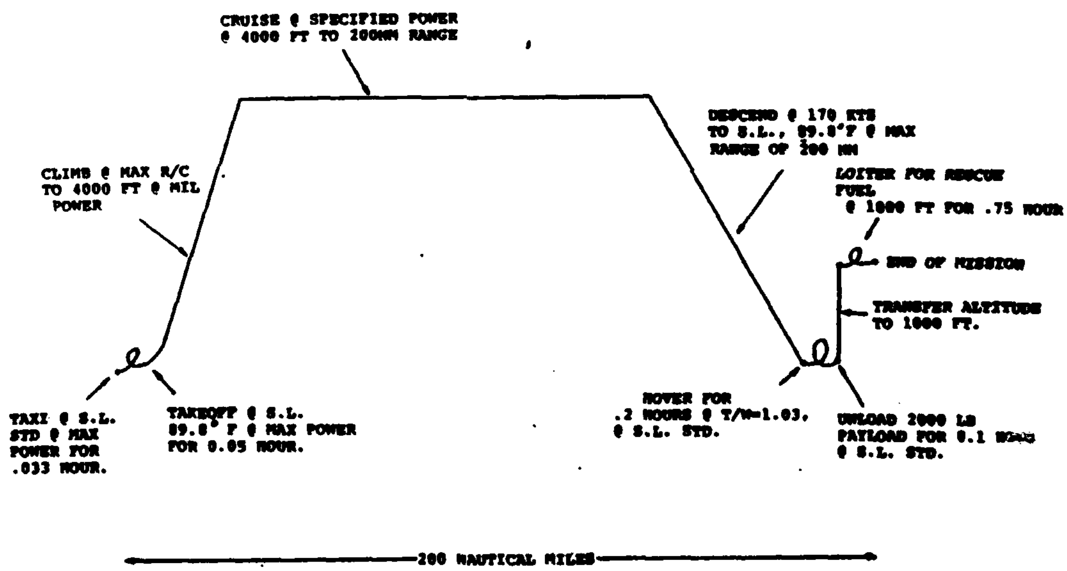

Figure 7-4. Design Mission - Sample Case No. 4

SAMPLE CASE NO. 4 RUN 1

GENERAL INFORMATION SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
OPTIND	0001	1.	Sizing run
OPTIONAL PRINT	0002	1.	Detailed printout desired
DGRIND	0003	2.	GW/F_e drag trend utilized. Locations 0312 and 0313 must be input.
OSWIND	0004	1.	Program calculates e.
CNFIND	0005	1.	This case is an ABC helicopter run as a single rotor.
AUXIND	0006	3.	Compound helicopter with auxiliary propulsion only. Location 0012 must be input.
RDMIND	0007	2.	Input disc loading and solidity.
FIXIND	0008	1.	Program sizes primary engines.
ROTIND	0009	5.	L/D_e rotor map input. Rotor is operated at max. rotor L/D_e with TAUX/T as output. Program accepts V_{TIP} schedule. Location 0006 must be greater than 2, and Location 0253 must equal 0.
AIPIND	0012	1.	No independent auxiliary engines.
TRDIND	0015	2.	No anti-torque tail rotor on this design.
VTFIND	0017	1.	Input locations 0135 and 0138, AR_{VT} and ζ_{VT}, respectively.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
HTIND	0018	2.	Horizontal tail volume coefficient input.
MRPIND	0019	0.	Main rotor position on fuselage input by user.
ESCIND	0022	1.	Primary engines are sized for either takeoff or cruise.
WG_O	0023	40000.	First guess at design gross weight.
H_O	0024	0.	Initial altitude.
R_O	0025	0.	Initial range.
T_O	0026	0.	Initial starting time.
H_{OPTIND}	0027	0.	Cruise at specified altitude.
M_{MD}	0028	.456	Maximum operating Mach number.
V_{MO}	0029	250.	Maximum operating equivalent airspeed in knots.
V_{DIVE}	0030	300.	Dive speed - approximately equal 1.2 x V_{MO} in knots.
M_{LF}	0031	3.	Maneuver load factor.
K_1	0032	1.0562	Factor on mission fuel burned to give reserve fuel. 1.0562 results in 5% of initial fuel for reserve.
δW_F	0033	0.	Fixed fuel increment for reserves or other use.
K_{FF}	0034	1.05	Increase basic engine SFC by 5%.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
SGTIND	0035	1.0	Taxi
	0036	2.0	Takeoff
	0037	3.0	Climb
	0038	4.0	Cruise
	0039	5.0	Descent
	0040	2.0	Hover
	0041	8.0	Transfer payload
	0042	9.0	Transfer altitude
	0043	60.0	Loiter for reserve fuel
	0044	100.0	End of case

HELICOPTER DIMENSIONAL INFORMATION SHEET

AR_{HT}	0112	4.178	Horizontal tail aspect ratio.
ℓ_{TH}'	0113	.7866	Ratio of horizontal tail moment arm to main rotor radius.
$(t/c)_{HT}$	0114	.15	Horizontal tail thickness/chord ratio.
$\bar{V}_H$	0115	.0192	Horizontal tail volume coefficient referred to main rotor diameter and tail arm.
λ_H	0116	.555	Horizontal tail taper ratio.
$\Delta S_{WET}/S_F$	0120	0.	Fuselage wetted area ratio.
ΔS_{WET}	0121	0.	Incremental fuselage wetted area.
h_F	0122	8.276	Fuselage height.
W_F	0123	8.276	Fuselage width.
$(\ell/d)_P$	0124	1.007	Fineness ratio of nose.
$(\ell/d)_T$	0125	1.329	Fineness ratio of tail.
ℓ_C	0126	23.5	Constant diameter section length

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ℓ_{RW}	0127	15.	Length of ramp well.
(X_M/ℓ_B)	0128	.4825	Main rotor position aft of the nose as a fraction of main fuselage length.
$(\ell_{TB}/d_{\bar{T}B})$	0129	2.133	Fineness ratio of tail boom.
$(d_{\overline{TT}_B}/d_{\bar{T}B})$	0130	.2	Ratio of average tail boom tip diameter to average tail boom diameter.
AR_{VT}	0135	1.5	Vertical tail aspect ratio.
λ_{VT}	0136	.5	Vertical tail taper ratio.
$(t/c)_{VT}$	0137	.15	Thickness/chord ratio of vertical tail.
K_Z or b_{VT}	0139	9.274	Variable is b_{VT} for this case of an ABC helicopter. Locations 0005 and 0017 must equal 1.0, and location 0015 must equal 0.0.
η_1	0142	0.	Primary engine nacelle dimensional factors.
η_2	0143	0.	
η_3	0144	0.	
(ℓ_{A1P}/ℓ_c)	0145	0.	Ratio of air induction system length to primary engine length.
η_4	0146	0.	Auxiliary independent engine nacelle dimensional factors.
η_5	0147	0.	
η_6	0148	0.	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
(ℓ_{aia}/ℓ_{ea})	0149	0.	Ratio of air induction system length to auxiliary engine length.
$\Delta S/S_{STR}$	0150	0.	Ratio of incremental auxiliary engine nacelle strut planform area to auxiliary engine nacelle strut planform area.
$b_{NS}/d_{\tilde{N}I}$	0151	0.	Ratio of auxiliary independent engine nacelle strut span to nacelle diameter.
$(t/c)_{RF}$	0152	.21190	Main rotor pylon root thickness/chord ratio.
$(t/c)_{TF}$	0153	.2164	Main rotor pylon tip thickness/chord ratio.
AR_{FP}	0154	.1928	Main rotor pylon aspect ratio.
λ_{FP}	0155	.6381	Forward rotor pylon taper ratio.
h_{P_1}	0156	2.	Main rotor pylon height.

ROTOR DIMENSIONAL DATA FOR SIZING MAIN ROTOR

Rotor Map No.	0170	125.	Coaxial rotor helicopter figure of merit and cruise L/D_E rotor map.
N_R	0172	1.	Number of rotors.
W/A	0173	15.	Main rotor disc loading.
σ_{MR}	0175	.1397	Main rotor solidity
b_{MR}	0176	8.	Number of main rotor blades.
θ_{TMR}	0177	-10.	Main rotor twist (degrees)

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$X_{C_{MR}}$	0178	.1	Main rotor blade cutout as a fraction of radius.
X_{MR}	0179	.07	Main rotor blade attachment point as a fraction of radius.
(t/c).25R	0180	.32	Rotor blade thickness/ chord at 25 percent radius.
$V_{TIP_{REF}}$	0181	723.51	Main rotor tip speed.
V_{CEH1}	0191	1.53	Main rotor vertical rate of climb efficiency factors.
V_{CEH2}	0192	0.	
$K_{P_{CLIMB}}$	0193	.87	Helicopter forward flight climb efficiency.
$K_{P_{DESCENT}}$	0194	.87	Helicopter forward flight descent efficiency.

ROTOR DIMENSIONAL DATA FOR SIZING TAIL ROTOR

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$g_{MR/TR}$	0214	0.	Gap between main and tail rotor disc (FT). When location 0015=0 (TRDIND), represents gap between main rotor disc and end of tail boom (FT). A negative number would imply tail boom ends under the main rotor disc.
$C_{L_{FIN}}$	0216	0.	Vertical tail fin operating cruise lift coefficient.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
PRIMARY ENGINE SIZING INFORMATION SHEET			
Primary Engine Cycle No.	0217	1.82	Primary engine selection.
N_p	0219	4.	Number of primary engines.
XMSNIND	0220	2.	Drive system ratings specified as fraction of primary engine installed power required to hover or cruise at design conditions. The more critical of the two conditions is selected.
SHP_{MRX}/SHP^*_{MR}	0221	.9363	Main rotor drive system is rated at 93.63% of main rotor design power.
$K_{ALT\ PAYL}$	0222	0.	Ratio of main rotor drive system XMSN rating to main rotor design power.
η_T	0223	.97	Transmission efficiency.
ΔSHP_{ACC}	0224	0.	Accessory power losses.
SHP_{AUX}/SHP^*_{AUX}	0226	.9364	Auxiliary propulsion drive system rating as a fraction of auxiliary propulsion system installed power. When no auxiliary engines are specified, this input specifies the auxiliary drive system is rated to 93.64% of main rotor design power.
$h_{TO(H)}$	0227	0.	Design point hover attitude for engine sizing.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$(T/W)_D$	0228	1.13	Configuration design point hover thrust/weight ratio.
$\Delta T_{IN_{TO(H)}}$	0229	30.8	Temperature increment in degrees above standard at altitude for engine sizing.
$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{TO}$	0230	.943	Operating point for engine power turbine. Operating tip speed is computed from

$$V_{T_{Operating}} = V_T \left[\frac{N_{II}}{N_{II_{MAX}}}\right] \left[\frac{N_{II_{MAX}}}{N_{II^*}}\right]$$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
N_{PSD}	0231	0.	Number of engines inoperative at hover design point conditions.
SHP_E/SHP^*	0232	1.	Engines sized to permit operation at 100% of maximum rated power.
$\left(V_{R/C}\right)_D$	0233	0.	0 ft/min vertical rate of climb capability required at hover design point.
POWIND	0234	2.	Maximum engine rating for cruise engine sizing. For this example, normal rated power is the maximum to be used.
h_C	0235	0.	Design point cruise altitude for engine sizing.
V_C	0236	250.	Design point cruise speed for engine sizing.
$\Delta T_{IN_{CE}}$	0237	0.	Temperature increment above standard for cruise engine sizing.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_C$	0238	10.943	This location specifies the operating point for engine power turbine at design cruise conditions. However, in this example, since $\frac{N_{II}}{N_{II_{MAX}}}$ is between 10. and 20., the program assumes a V_{TIP} schedule mix of $M_{ADV_{TIP}}$ and V_{TIP} as designated by locations 1258 to 1278.
$\left(T_{AUX}/T_{TOT}\right)_C$	0239	1000.	This value signifies that the propulsive thrust provided by auxiliary propulsion at cruise condition for engine sizing follows the input schedule in locations 1671-1692.
$\left(N_{PSD}\right)_C$	0241	0.	Number of primary engines shut down during cruise (for engine sizing).

PROPELLER DATA REQUIRED FOR COMPOUND HELICOPTER AUXILIARY PROPULSION INFORMATION SHEET

No. of Props	0248	2.	Two auxiliary propellers are used on this configuration.
V_{TAR}	0249	927.	Auxiliary propeller tip speed.
DIA	0250	6.	Diameter of auxiliary prop/fan is 6 ft.
X_{AR}	0251	.15	Prop/fan blade attachment point as a fraction of radius.
η_{TAUX}	0252	.97	Transmission efficiency of auxiliary drive system

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$\eta_{P_{IND}}$	0253	0.	Table of prop/fan efficiencies are input.
η_{P_3}	0254	.7	Prop/fan climb efficiency.
η_{P_4}	0255	.5	Prop/fan descent efficiency.
AF/Blade	0257	100.	Prop/fan activity factor per blade. For this example, a 4 bladed 400 total activity prop/fan was selected.
No. of blades	0258	4.	Number of prop/fan blades.
No. of pairs in η_{P_4} Table	0261	2.	Number of pairs in prop/fan efficiency table, locations 0262-0281.
Values of Mach No.	0262 0263	0 .6	Values of Mach number in cruise efficiency table.
Values of η_{P_4}	0272 0273	.8 .8	Values of cruise efficiency at corresponding Mach number.

HELICOPTER AERODYNAMICS INFORMATION SHEET

GW/F_e	0312	1762	Drag trend constants derived from data such as illustrated by Figure 4-30, Section 4.9.
K_{FED}	0313	0.561	
TFEF	0315	1.	Tail fin aspect ratio effectiveness factor.
K_W	0327	1.	Wing multiplicative drag factor.
No. of C_X/σ	0347	3.	Specifies number of C_X/σ values in table locations 0349-0354.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
No. of μ	0348	3.	Specifies number of μ values in table locations 0354-0360.
Values of C_X/σ	0349 0350 0351	-1 0 1	Rotor propulsive thrust coefficient divided by main rotor solidity. Used in defining rotor limits.

$$C_X/\sigma = \frac{\text{THRUST REQUIRED}}{\dfrac{\rho\pi\, D_{MR}^2\, N_R\, V_{TIP}^2\, \sigma_{MR}}{4}}$$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Values of μ	0354 0355 0356	0 .5 1.	Rotor forward flight advance ratio $\mu = \frac{V_{FPS}}{V_{TIP}}$
Values of C_T'/σ	0361 0362 0363	1. 1. 1.	Values of C_T'/σ corresponding to $(C_X/\sigma)_1$ location 0349 and μ_1, μ_2, and μ_3.
	0368 0369 0370	1. 1. 1.	Values of C_T'/σ corresponding to $(C_X/\sigma)_2$ location 0350 and μ_1, μ_2, and μ_3.
	0375 0376 0377	1. 1. 1.	Values of C_T'/σ corresponding to $(C_X/\sigma)_3$ location 0351 and μ_1, μ_2 and μ_3.

HELICOPTER WEIGHT INFORMATION SHEET

W_{FE}	2602	5622.	Weight of fixed equipment in LBS.
W_{FUL}	2603	1550.	Weight of fixed useful load in LBS.
W_{PL}	2604	5630.	Weight of payload in LBS.
ΔW_{FC}	2605	0.	Flight controls group incremental weights in LBS.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ΔW_P	2606	0.	Propulsion group incremental weight in LBS.
ΔW_{ST}	2607	700.	Structures group incremental weight in LBS.
RM_1	2608	0.	Wing relief as percentage of GW.
W_i	2609	0.	Weight of inboard store.
W_o	2610	0.	Weight of outboard store.
d_i	2611	0.	Position of inboard underwing store (fraction of wing semi-span).
d_o	2612	0.	Position of outboard underwing store (fraction of wing semi-span).
k_{CC}	2613	26.	Cockpit controls weight factor.
k_{RC}	2614	30.	Main rotor controls weight factor.
k_{SC}	2615	30.	Main rotor system controls weight factor.
k_{FW}	2616	.005	Fixed wing controls.
k_{TM}	2617	0.	Tilt mechanism weight factor.
k_{SAS}	2618	75.	Stability Augmentation System (SAS) weight factor. Usually in the range of 20-100 pounds.
k_{RCA}	2619	18.	Auxiliary rotor controls weight factor.
k_{SCA}	2620	25.	Auxiliary rotor system controls weight factor.
k_{MC}	2621	0.	Miscellaneous controls weight factor in LBS.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_B	2622	125.	Body group weight factor.
ΔC.G.	2623	2.08	Helicopter cg travel (FT).
k_{LG}	2624	.04	Landing gear weight factor. Percentage of gross weight.
k_{MG}	2625	.8	Main landing gear weight factor.
k_{WW}	2626	0.	Detailed wing weight factor. This adjusts the constant 220 in $W_W = 220(k)^{0.585}$ up or down depending on the complexity of the control surfaces.
LF	2627	1.	Wing unload factor. Entered as a fraction of design gross weight.
k_{WS}	2628	0.	Wing stores only weight trend factor.
k_{WP}	2629	0.	Wing weight/area factor (psf).
k_{HT}	2630	2.5	Horizontal tail unit weight in PSF.
k_{CLF}	2631	0.	Crash load factor.
k_{NAC}	2632	0.	Primary cowling weight factor (PSF).
k_{AIP}	2633	0.	Primary air induction system weight factor.
k_{NACA}	2634	0.	Auxiliary cowling weight factor (PSF).
k_{AIA}	2635	0.	Auxiliary air induction system weight factor.
k_{NS}	2636	0.	Nacelle strut weight factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{PRB}	2637	44.	Primary rotor blade weight factor.
k_{RBF}	2638	2.2	Rotor type factor; hingeless for this example.
k_{PH}	2639	61.	Primary hub weight factor.
k_{amd}	2640	.286	Main rotor weight factor.
k_{BLFD}	2641	1.1948	Blade fold weight factor. Input as a fractional part of the total rotor weight.
k_{TR}	2642	0.	Tail rotor weight factor.
k_{AR}	2643	14.2	Auxiliary rotor weight factor. This is the average value for the rotor or propeller weight (LB). $W_R = 14.2\ a(k)^{.67}$
k_{PA}	2644	1.	Auxiliary rotor multiplicative input power, expressed here as 100% input power.
k_{VTAR}	2645	1.	Auxiliary tail rotor multiplicative tip speed factor expressed here as 100% input speed.
k_{PDS}	2646	265.	Primary drive system weight factor.
k_{PDSZ}	2647	3.	Primary drive system weight factor. Number of gears in system.
k_{TRDS}	2648	0.	Tail rotor drive system weight factor.
k_{ADS}	2649	0.	Auxiliary drive system weight factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{ADSZ}	2650	1.	Auxiliary drive system weight factor (number of gears in system).
k_{FS}	2651	.15	Fuel system weight factor.
k_{PE}	2652	.3	Primary engine installation weight factor.
k_{AE1}	2653	0.	Auxiliary engine installation weight factor.
K_1	2654	1.	Main rotor control weight factor.
K_2	2655	1.206	Main rotor system controls weight multiplicative factor.
K_3	2656	1.	Fixed wing controls weight multiplicative factor.
K_4	2657	1.	Auxiliary rotor controls weight multiplicative factor.
K_5	2658	1.	Auxiliary rotor system controls weight multiplicative factor.
K_6	2659	0.85	Body weight multiplicative factor.
K_7	2660	.85	Landing gear weight multiplicative factor.
K_8	2661	1.	Wing weight multiplicative factor.
K_9	2662	.85	Horizontal tail weight multiplicative factor.
K_{10}	2663	1.	Primary nacelle weight multiplicative factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
K_{11}	2664	1.	Auxiliary nacelle weight multiplicative factor.
K_{12}	2665	1.	Primary rotor blade weight multiplicative factor.
K_{13}	2666	1.6	Primary rotor hub weight multiplicative factor.
K_{14}	2667	1.	Tail rotor weight multiplicative factor.
K_{15}	2668	1.	Auxiliary rotor weight multiplicative factor.
K_{16}	2669	.93	Primary drive system weight multiplicative factor.
K_{17}	2670	1.	Auxiliary drive system weight multiplicative factor.
K_{18}	2671	1.	Primary engine weight multiplicative factor.
K_{19}	2672	1.	Auxiliary engine weight multiplicative factor.
K_{20}	2673	1.	Tail rotor drive system weight multiplicative factor.

TAXI INFORMATION (SGTIND = 1)

ATMIND	0401	0.	Standard atmosphere selected.
t_J(HR)	0411	.033	Time in hours to taxi.
$\left(\frac{N_I}{N_{I_{MAX}}}\right)$	0441	.943	Operating point for engine power turbine during taxi. $\left(\frac{N_{II}}{N_{II_{MAX}}}\right) = \frac{V_T \text{ OPERATING}}{V_T\left(\frac{N_{I_{MAX}}}{N_I^*}\right)}$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
TAKEOFF, HOVER, AND LANDING INFORMATION (SGTIND = 2)			
TOLIND	0461	2.	Specify power fraction and vertical rate of climb.
	0462	1.	Specify required T/W for hover out-of-ground effect.
ATMIND	0481	1.	Standard atmosphere plus an incremental temperature specified in location 0501.
	0482	0.	Standard atmosphere.
PEHF	0491	1.	Power fraction - 100% of power available at these ambient conditions is being used.
ΔT_{IN} (°F)	0501	30.8	Incremental temperature above standard, in degrees.
$V_{R/C}$ (FPM)	0511 0512	0. 0.	Off/min vertical rate of climb capability desired.
T/W	0522	1.03	Hover thrust/weight ratio specified.
Δt_H (HR)	0531 0532	.025 .1	Time increments for takeoff, hover or landing computations in hours.
$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)$ (PRIMARY ENGINE)	0541 0542	.943 .943	Operating point for engine power turbine during takeoff, hover or landing. $\left(\frac{N_{II}}{N_{II_{MAX}}}\right) = \frac{V_{T_{OPERATING}}}{V_T\left(\frac{N_{II_{MAX}}}{N_{II^*}}\right)}$
t_H (HR)	0551 0552	.05 .2	Takeoff, hover, or landing total time in hours.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
CLIMB INFORMATION (SGTIND = 3)			
CLMIND	0511	1.	Maximum rate of climb desired.
ATMIND	0591	1.	Standard atmosphere plus an incremental temperature specified in location 0611.
ΔT_{IN} (°F)	0611	30.8	Incremental temperatures above standard, in degrees.
Δh (FT)	0621	1000.	Altitude increments for climb calculations.
POWIND	0631	1.	Climb at maximum rate of climb limited by military power available.
h_{MAX} (FT)	0641	4000.	Final altitudes for climb.
$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)$ (PRIMARY ENGINE)	0651	10.943	This location specifies the operating point for engine power turbine at design climb conditions. However, in this example since $\frac{N_{II}}{N_{II_{MAX}}}$ is between 10. and 20., the program assumes a V_{TIP} schedule mix of $M_{ADV_{TIP}}$ and V_{TIP} as designated by locations 1258-1278.
ΔFe_{CL} (FT^2)	0661	0.	Incremental drag area in climb.
$N_{PSD_{CL}}$	0681	0.	Number of primary engines shut down during climb.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
T_{AUX}/T_{TOT}	0691	1000.	This value signifies that the propulsive thrust provided by auxiliary propulsion at CLIMB condition follows the input schedule in locations 1671-1692.
CRUISE INFORMATION (SGTIND = 4)			
CRSIND	0721	1.	Cruise at specified power setting.
ATMIND	0741	1.	Standard atmosphere plus an incremental temperature specified in location 0611.
ΔT_{IN}(°F)	0761	30.8	Incremental temperature above standard, in degrees.
ΔR(NM)	0771	40.	Calculation and printout increments during cruise in nautical miles.
POWIND	0781	2.	Cruise speed by normal rated primary engine power.
R_{MAX}(NM)	0791	200.	Values of range at end of each cruise segment.
$\left(\frac{N_{II}}{N_{II_{MAX}}}\right)$ (PRIMARY ENGINE)	0801	10.943	This location specifies the operating point for engine power turbine at design cruise conditions. However, in this example since $\frac{N_{II}}{N_{II_{MAX}}}$ is between 10. and 20., the program assumes a V_{TIP} schedule mix of $MADV_{TIP}$ and V_{TIP} as designated by locations 1258-1278.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$\Delta Fe_{CR}(FT^2)$	0811	0.	Increment in cruise equivalent flat plate area (FT^2).
$N_{PSD_{CR}}$	0831	0.	Number of primary engines shut down in cruise.
T_{AUX}/T_{TOT}	0841	1000.	This value signifies that the propulsive thrust provided by auxiliary propulsion at cruise condition follows the input schedule in locations 1671-1692.
DESCENT INFORMATION (SGTIND = 5)			
DESIND	0871	1.	Constant True Airspeed descent specified by location 0881.
TAS	0881	170.	Descend at a constant 170 knots.
RMAXIND	0891	0.	Terminal descent range specified. Location 0961 must be input.
ATMIND	0911	1.	Standard atmosphere plus an incremental temperature specified in location 0931.
Δh(FT)	0921	1000.	Calculation and printout increments during descent in nautical miles.
ΔT_{IN}(°F)	0931	30.8	Incremental temperature above standard, in degrees.
h_{MIN}(FT)	0941	0.	Specified minimum descent altitude (FT).
R/D (FPM)	0951	1000.	Rate of descent in ft/min.

AD-A113 037 BOEING VERTOL CO PHILADELPHIA PA F/G 9/2
HESCOMP. THE HELICOPTER SIZING AND PERFORMANCE COMPUTER PROGRAM--ETC(U)
OCT 79 S J DAVIS, H ROSENSTEIN, K A STANZIONE N62269-79-C-0217
UNCLASSIFIED D210-10699-2-REV-2. NADC-78265-60 NL

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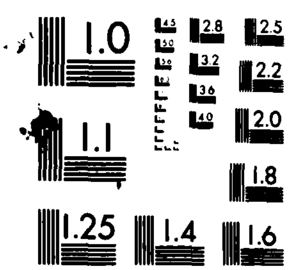

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
R_{MAX}(NM)	0961	200.	Maximum range at end of descent.
$\frac{N_{II}}{N_{II_{MAX}}}$ (PRIMARY ENGINE)	0971	10.943	This location specifies the operating point for engine power turbine at design descent conditions. However, in this example since $\frac{N_{II}}{N_{II_{MAX}}}$ is between 10. and 20., the program assumes a V_{TIP} schedule mix of $M_{ADV_{TIP}}$ and V_{TIP} as designated by locations 1258-1278.
$\Delta Fe_{DSC}(FT^2)$	0981	0.	Increment in descent equivalent flat plate drag area. (FT^2)
$N_{PSD_{DSC}}$	1001	0.	Number of primary engines shut down during descent.
T_{AUX}/T_{TOT}	1011	1000.	This value signifies that the propulsive thrust provided by auxiliary propulsion at descent conditions follows the input schedule in locations 1671-1692.

CHANGE IN PAYLOAD WEIGHT (SGTIND = 8)

ΔW_{PL}(LBS)	1161	-2000.	Unload 2000 pounds of payload.
t_{PW}(LBS)	1171	.01	Time in hours necessary to unload payload.
WGTIND	1191	1.	No weight restriction.

TRANSFER ALTITUDE (SGTIND = 9)

h_{FINAL}(FT)	1181	1000.	Transfer altitude to 1000 ft.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
LOITER INFORMATION, FOR RESERVE FUEL (SGTIND = 60)			
ATMIND	1031	0.	Standard atmosphere.
Δt_L(HR)	1061	.25	Calculation and printout increments, time in hours, during loiter.
$\frac{N_{II}}{N_{II_{MAX}}}$	1071	10.943	This location specifies the operating point for engine power turbine at design loiter conditions. However, in this example since $\frac{N_{II}}{N_{II_{MAX}}}$ is between 10. and 20., the program assumes a V_{TIP} schedule mix of $M_{ADV_{TIP}}$ and V_{TIP} as designated by locations 1258-1278.
t_L(HR)	1081	.75	Maximum time in hours for loiter.
$N_{PSD_{LOITER}}$	1101	0.	Number of primary engines shut down during loiter.
T_{AUX}/T_{TOT}	1111	1000.	This value signifies that the propulsive thrust provided by auxiliary propulsion at loiter conditions follows the input schedule in locations 1671-1692.
$\Delta Fe_L(FT^2)$	1131	0.	Increment in loiter equivalent flat plate drag area (FT^2).
PRIMARY ENGINE CYCLE DATA, NONSTANDARD PERFORMANCE			
WDTIND	1201	0.	No fuel flow cutoffs
N1IND	1202	0.	No N_I cutoffs
N1θIND	1203	0.	No referred N_1 cutoffs

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
N2IND	1204	2.	Free turbine engine to be simulated.
QIND	1205	0.	No torque limit imposed.
RNOIND	1206	0.	No Reynold's number corrections
$N_{II_{MAX}}/N_{II}^*$	1223	1.026	Value for N_{II} cutoff referred to N_{II}^*

ROTOR TIP SPEED OR MACH NUMBER SCHEDULE

No. of Pairs in V_{TIP}/M_{T90} Table	1258	4.	This value indicates that there are 4 pairs of input values in locations 1259 to 1278.
Values of M	1259	0.	In this example problem, it was desired to have the rotor tip speed schedule follow 700 FPS up to 180 kts forward flight speed. At this point, the schedule will then follow the necessary tip speed to produce a
	1260	.2722	
	1261	.3781	
	1262	.4539	
Corresponding Values of $V_{TIP_{REF}}$ and $M_{T90_{REF}}$	1269	723.51	
	1270	723.51	
	1271	.9	
	1272	.9	

constant tip sea level standard Mach number of 0.9 at 90°. The schedule is a plot of Tip Speed (FPS) versus True Airspeed (kts) for lines of contant μ. The 180 kt transition point is shown in location 1260, where $M = \frac{V_{FWD}}{a} = \frac{180\text{ kt}}{661.2\text{ kt}} = .2722$

and a = speed of sound at sea level standard. The corresponding reference tip speed in location 1270 is 723.51 FPS, obtained through the relation; $V_{T_{REF}} = \dfrac{V_T}{\left(\dfrac{N_{II}}{N_{II_{MAX}}}\right)\left(\dfrac{N_{II_{MAX}}}{N_{II}^*}\right)}$

where $\dfrac{N_{II}}{N_{II_{MAX}}}$ is input in location 0230, and $\dfrac{N_{II_{MAX}}}{N_{II}^*}$ is input in

in location 1223. V_T is found in location 0181.

For this case:

$$V_{T_{REF}} = \frac{700}{(.943)(1.026)} = 723.51$$

Assuming that the maximum true airspeed will not exceed 300 kts, this velocity was chosen for the end point on the M_{T90} line. This velocity is input in location 1262 as .4539. The corresponding V_{TREF} is simply the limiting tip Mach number = 0.9. The same reasoning is similar for location 1261 and 1271 using a true airspeed of 250 kts. Note, actual V_{TIP} can be calculated from the following equation:

$$V_T = a\, M_{T190} - V_{FWD}$$

- AUXILIARY PROPULSION SCHEDULE (T_{AUX}/T)

The Tip Speed versus True Airspeed plot used for the Rotor Tip Speed or Mach Number Schedule can be used for the determination of μ in the T_{AUX}/T Schedule.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
No. of Pairs in T_{AUX}/T Table	1671	4.	This location indicates that there are 4 pairs of input values in locations 1672-1691.
Values of μ	1672	0.	In this example, the design criteria was to have auxiliary propulsion after a true airspeed of 100 kts, up to a maximum of 300 kts. For the 100 kt minimum airspeed necessary for auxiliary propulsion, location 1673 is obtained from:
	1673	.202	
	1674	.5062	
	1675	1.0	
Corresponding Values of T_{AUX}/T	1682	0.	
	1683	0.	
	1684	.5	
	1685	1.0	

$$M_{T90_{REF}} = \frac{V_{FWD} + V_T}{a}, \text{ where } V_{FWD} = 100 \text{ kts}$$

solving for $V_T = (.9)(661.2) - 100 = 495$ kts

and $\mu = \dfrac{V_{FWD}}{V_{TIP}} = \dfrac{100}{495} = .202$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$(T_{AUX}/T_{TOT})_C$	0239	2000.	These values signify that the propulsive thrust provided by auxiliary propulsion at cruise condition for engine sizing follows the input schedule in locations 1671-1692 up to the transition μ indicated by location 1692. Above that μ, the maximum L/D_E is used. This option used only with ROTIND > 2. This T_{AUX}/T_{TOT} input can be used in all T_{AUX}/T_{TOT} locations.
(T_{AUX}/T_{TOT}) FOR:			
climb	0691		
cruise	0841		
descent	1011		
Values of $VTIP_{REF}$	1271	596.4	These values replace the Mach numbers in the same locations as used in Run 1. Since $\frac{N_{II}}{N_{IIMAX}}$ is
	1272	510.7	

greater than 20, the program assumes V_{TIP} schedule is in V_{TIP} only. For location 1271, the Mach number = .3781. Therefore, V_T in ft/second equals:

$$V_T = 1.6744\ (a(M_{T90}) - V_{FWD}) = 577 \text{ FPS}$$

where 1.6744 converts knots to FPS.

The V_T is now put in its referred form

$$VT_{REF} = \frac{V_T}{\left(\frac{N_{II}}{N_{IIMAX}}\right)\left(\frac{N_{IIMAX}}{N_{II^*}}\right)}$$

$$VT_{REF} = \frac{577}{(.943)(1.026)} = 596.4 \text{ FPS}$$

The same procedure can be repeated to determine location 1272.

Likewise, locations 1674 and 1675 were calculated using forward flight speeds of 200 kts and 300 kts, respectively. The corresponding T_{AUX}/T locations were arbitrarily chosen.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
SAMPLE CASE NO. 4 RUN 2			
ROTIND	0009	6.	L/D_E rotor map input. Rotor is operated at maximum configuration L/D_E with T_{AUX}/T as output. Program accepts V_{TIP} schedule. Location 0006 must be greater than 2, and location 0253 must equal 0.
SAMPLE CASE NO. 4 RUN 3			
$\frac{N_{II}}{N_{II_{MAX}}}$ C	0238	20.943	These locations specify the operating point for engine power turbine at design cruise conditions. However, in this example since $\frac{N_{II}}{N_{II_{MAX}}}$ is greater than 20, the program assumes a V_{TIP} schedule only and not a mixture of V_{TIP} and $MADV_{TIP}$. This value can be used on all locations of $N_{II}/N_{II_{MAX}}$.
	0801		
	0971	20.943	
	1071		

H S C O P P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   P-91

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+.001
VAL2 VALUE CORRESPONDING TO LOC.+.002
ETC.

NOTE : IN USING AUXILIARY ENGINES : AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED
BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
12[illegible]1	5	.[illegible]	.[illegible]	.1	2.[illegible]	.
12[illegible]6	1	.[illegible]				
12[illegible]	2	1.6260	.0			
125[illegible]	1	4.[illegible]				
125[illegible]	4	.[illegible]	.27220	.378[illegible]	.4[illegible]	
126[illegible]	4	723.51	723.51	.[illegible]	.[illegible]	
1[illegible]71	5	4.00[illegible]	.0	.292.[illegible]	.[illegible]20	1.[illegible]
1[illegible]2	4	.	.[illegible]	.[illegible]	1.[illegible]	
1[illegible]2	1	.2[illegible]				
13[illegible]1	5	1.[illegible]	.96[illegible]E-01	[illegible]	.3[illegible]E-01	17[illegible]
13[illegible]6	5	1[illegible]	2522.0	2645.	2645.[illegible]	[illegible]
1311	5	1[illegible]0.0	19[illegible].0	2150.0	24[illegible]	26[illegible]
1316	5	2[illegible]	32[illegible]	[illegible]	6.[illegible]	.
1321	5	.2[illegible]	.4[illegible]00	.66000	.70[illegible]	1.[illegible]
1326	5	.230[illegible]E-01	.2[illegible]00E-01	.23[illegible]E-01	.2[illegible]E-01	.2[illegible]E-01
1331	5	.23[illegible]E-01	.1[illegible]	.1[illegible]	.1[illegible]	.153
1336	5	.194[illegible]	.2[illegible]	.392[illegible]	.39[illegible]	.4[illegible]
1341	5	.41100	.421[illegible]	.455[illegible]	.6[illegible]	.7[illegible]1
1346	5	.71[illegible]	.72[illegible]	.73600	.[illegible]	1.[illegible]
1351	5	1.[illegible]2[illegible]	1.[illegible]42[illegible]	1.[illegible]97[illegible]	1.[illegible]	1.3[illegible]
135[illegible]	5	1.244[illegible]	1.2749	1.32[illegible]	1.39[illegible]	1.46[illegible]
1361	5	1.[illegible]	1.4399	1.4[illegible]	1.540[illegible]	1.[illegible]54
1366	5	1.7500	2.2[illegible]00	1.5[illegible]	1.[illegible]	1.7
1371	5	1.[illegible]2[illegible]	1.[illegible]	2.[illegible]	[illegible]	1[illegible]0.0
1376	5	15[illegible].0	215[illegible]	24[illegible]	2[illegible]	[illegible]
13[illegible]1	5	32[illegible].0	35[illegible]	6.[illegible]	.	.2
13[illegible]6	5	.4[illegible]	.[illegible]	.70[illegible]	1.[illegible]	.2[illegible]E-01
1391	5	.20000E-01	.2[illegible]E-01	.20000E-01	.2[illegible]E-01	.2[illegible]E-01
1396	5	.1[illegible]2[illegible]	.1[illegible]20[illegible]	.162[illegible]	.16[illegible]	.162[illegible]
14[illegible]1	5	.162[illegible]	.24[illegible]	.244[illegible]	.244[illegible]	.245
14[illegible]6	5	.245[illegible]0	.246[illegible]	.355[illegible]	.3[illegible]6	.35[illegible]
1411	5	.36[illegible]	.361[illegible]0	.375[illegible]	.47[illegible]	.477
1416	5	.48500	.4[illegible]00	.49760	.53[illegible]	.562
1421	5	.574[illegible]	.[illegible]	.59[illegible]0	.625	.[illegible]
1426	5	.64[illegible]	.664[illegible]	.675[illegible]	.7[illegible]3	.727
1431	5	.[illegible]4590	.74[illegible]	.755	.772	.[illegible]1
1436	5	.[illegible]4[illegible]	.[illegible]	[illegible]	15[illegible].[illegible]	1[illegible].
1441	5	2150.0	240[illegible].0	2650.0	2[illegible]0.0	32[illegible].

1446	5	3550.0	6.0000	.0	.2[illegible]	.4[illegible]
1451	5	.66000	.73000	1.0000	.7[illegible]	.7[illegible]
1456	5	.70000	.70000	.70000	.70000	.845[illegible]
1461	5	.84500	.84500	.845[illegible]	.645[illegible]	.845[illegible]
1466	5	.898[illegible]	.89800	.89800	.89800	.89800
1471	5	.95000	.95000	.95000	.95000	.95[illegible]
1476	5	.95000	.95000	1.0010	1.0010	1.001[illegible]
1481	5	1.0010	1.0010	1.0010	1.0480	1.048[illegible]
1486	5	1.0480	1.0480	1.0480	1.0480	1.1020
1491	5	1.1020	1.1020	1.1020	1.1020	1.1020
1496	5	1.1540	1.1540	1.1540	1.1540	1.154[illegible]
1501	5	1.1540	6.0000	1500.0	19[illegible].0	215[illegible]
1506	5	24[illegible].0	265[illegible].0	29[illegible].0	32[illegible].0	355[illegible]
1511	5	6.0000	.0	.20000	.40000	.6[illegible]
1516	5	.7[illegible]	1.[illegible]	.225[illegible]	.225[illegible]	.225[illegible]
1521	5	.225[illegible]	.22500	.225[illegible]	.59[illegible]	.55[illegible]
1526	5	.59000	.59000	.59[illegible]	.59[illegible]	.748[illegible]
1531	5	.752[illegible]	.75600	.761[illegible]	.766[illegible]	.778[illegible]
1536	5	.89000	.89500	.90000	.90500	.91[illegible]
1541	5	.932[illegible]	1.0[illegible]	1.009[illegible]	1.014[illegible]	1.[illegible]19[illegible]
1546	5	1.0240	1.0520	1.0810	1.[illegible]870	1.[illegible]93[illegible]
1551	5	1.1300	1.1360	1.1380	1.145[illegible]	1.155[illegible]
1556	5	1.165[illegible]	1.1750	1.18[illegible]	1.21[illegible]	1.21[illegible]
1561	5	1.2250	1.2300	1.2400	1.2500	1.2746
3420	1	125.[illegible]				
3421	3	6.[illegible]	.11100	-1[illegible].00[illegible]		
3424	1	10.0[illegible]				
3425	5	.2[illegible]E-01	.4[illegible]00E-01	.50000E-01	.6[illegible]00E-01	.7[illegible]E-01
3430	5	.80000E-01	.12000	.16000	.2[illegible]	.24[illegible]
3435	1	3.[illegible]				
3436	3	.[illegible]	.6[illegible]	.[illegible]000[illegible]		
3442	5	.368[illegible]	.59[illegible]00	.648[illegible]	.681[illegible]	.7[illegible]6[illegible]
3447	5	.723[illegible]	.747[illegible]	.741[illegible]	.721[illegible]	.7[illegible]5[illegible]
3452	5	.36800	.59[illegible]00	.64860	.6[illegible]100	.7[illegible]6[illegible]
3457	5	.723[illegible]	.74700	.741[illegible]	.721[illegible]	.7[illegible]5[illegible]
3462	5	.368[illegible]	.59[illegible]	.648[illegible]	.6[illegible]1[illegible]	.7[illegible]6[illegible]
3467	5	.723[illegible]	.74700	.741[illegible]	.721[illegible]	.7[illegible]5[illegible]
3502	1	6.[illegible]				
3503	5	-.16000	-.[illegible]0000E-01	.0	.5[illegible]E-01	.1[illegible]
3508	1	.2[illegible]				
3509	1	1[illegible]				
3510	5	.[illegible]	.2[illegible]000E-01	.40000E-01	.6[illegible]E-01	.[illegible]E-01
3515	5	.10000	.12000	.14000	.16[illegible]	.22[illegible]
3520	1	1.[illegible]				
3521	5	.10000E-01	.[illegible]000E-01	.1[illegible]	.15[illegible]	.[illegible]1[illegible]
3526	5	.30[illegible]	.35[illegible]00	.47[illegible]	.6[illegible]00	.91000
3531	5	.[illegible]	.76[illegible]	1.275[illegible]	1.365[illegible]	1.2[illegible]
3536	5	.[illegible]000	.57[illegible]	.33[illegible]	.16[illegible]	.[illegible]E-01
3541	5	.	2.34[illegible]	3.975[illegible]	3.915	3.27[illegible]
3546	5	2.5500	1.9650	1.5750	1.17[illegible]	.7[illegible]
3551	5	.[illegible]	3.[illegible]75[illegible]	[illegible].39[illegible]	[illegible].42[illegible]	6.[illegible]500
3556	5	4.565	4.35[illegible]	3.675[illegible]	2.[illegible]5[illegible]	1.[illegible]3[illegible]
3561	5	.[illegible]	4.[illegible]75	[illegible].[illegible]7[illegible]	[illegible]	[illegible].[illegible]65
3566	5	7.62	6.[illegible]	5.67[illegible]	4.[illegible]60[illegible]	3.[illegible]
3571	5	.0	[illegible].2[illegible]00	9.[illegible]010	11.[illegible]2[illegible]	11.17[illegible]
3576	5	10.425	9.4[illegible]	8.2[illegible]	[illegible].82[illegible]	[illegible].2[illegible]
3581	5	.[illegible]	4.[illegible]200	9.165[illegible]	12.3[illegible]	14.5[illegible]
3586	5	14.910	13.725	12.225	1[illegible].77[illegible]	9.15[illegible]
3591	5	.	4.[illegible]75[illegible]	8.625[illegible]	12.[illegible]	14.7[illegible]
3596	5	15.750	15.[illegible]00	14.175	12.[illegible]75	11.[illegible]25

36 1	5	.0	3.[illegible]00	5.4[illegible]	7.275	8.65[illegible]
3606	5	9.90[illegible]	1[illegible].575	10.675	1[illegible].575	9.45[illegible]
3611	5	.0	2.3700	3.9300	5.43[illegible]	6.525[illegible]
3616	5	7.3500	7.950[illegible]	6.25[illegible]	8.13[illegible]	6.[illegible]25[illegible]
3621	5	.0	1.6750	3.0[illegible]	4.2750	5.3250
3626	5	6.225[illegible]	6.[illegible]00	7.200[illegible]	7.125[illegible]	5.[illegible]
3631	5	.0	.57[illegible]00	.885[illegible]	.9[illegible]	.735[illegible]
3636	5	.6[illegible]	.48000	.31500	.245[illegible]	.15[illegible]
3641	5	.0	2.2200	3.750[illegible]	3.75[illegible]	3.[illegible]
3646	5	2.55[illegible]	2.1750	1.800[illegible]	1.3650	.84000
3651	5	.0	3.6[illegible]00	6.6750	6.[illegible]15[illegible]	5.85[illegible]
3656	5	5.1[illegible]	4.3[illegible]00	3.6750	2.55[illegible]	1.[illegible]5[illegible]
3661	5	.0	4.7400	7.8750	8.70[illegible]	8.25[illegible]
3666	5	7.2750	6.3700	5.37[illegible]	4.23[illegible]	3.[illegible]75[illegible]
3671	5	.0	5.25[illegible]0	9.[illegible]30[illegible]	1[illegible].725	10.650
3676	5	9.[illegible]250	6.775[illegible]	7.575[illegible]	6.225[illegible]	4.725[illegible]
3681	5	.0	5.[illegible]25[illegible]	6.21[illegible]	12.150	12.35[illegible]
3686	5	13.[illegible]2	12.[illegible]0[illegible]	10.715	9.15[illegible]	7.575[illegible]
3691	5	.0	4.5750	8.6250	11.925	13.725
3696	5	13.53[illegible]	13.[illegible]50	11.85[illegible]	10.[illegible]0	9.0000
37 1	5	.0	3.2250	6.0[illegible]	8.40[illegible]	1[illegible].2[illegible]
37 6	5	11.4[illegible]	12.[illegible]00	11.625	1[illegible].425	8.925[illegible]
3711	5	.0	2.4[illegible]00	4.6200	6.[illegible]75[illegible]	8.22[illegible]
3716	5	9.5100	10.335	10.620	10.32[illegible]	9.675[illegible]
3721	5	.0	1.9[illegible]0	3.75[illegible]	5.4[illegible]	6.[illegible]
3726	5	7.50[illegible]	8.1[illegible]0	6.325[illegible]	8.[illegible]25[illegible]	7.5[illegible]
3731	5	.0	.6[illegible]00	.[illegible]90[illegible]	.825[illegible]	.675
3736	5	.57[illegible]	.35[illegible]0	.27[illegible]	.[illegible]5[illegible]	.12[illegible]
3741	5	.0	2.1450	3.0000	3.[illegible]	2.[illegible]
3746	5	2.[illegible]2[illegible]	1.7100	1.365[illegible]	1.125[illegible]	.78[illegible]
3751	5	.0	3.[illegible]450	5.355[illegible]	5.[illegible]5[illegible]	5.[illegible]4[illegible]
3756	5	4.1850	3.4800	3.000[illegible]	2.415[illegible]	1.62[illegible]
3761	5	.0	4.65[illegible]	7.[illegible]95[illegible]	7.875[illegible]	7.365
3766	5	6.4800	5.5650	4.7100	3.7500	2.5250
3771	5	.0	5.25[illegible]0	8.85[illegible]	1[illegible]	9.75[illegible]
3776	5	8.925[illegible]	6.[illegible]250	6.825[illegible]	5.55[illegible]	4.[illegible]5[illegible]
3781	5	.0	5.[illegible]250	9.3[illegible]00	11.615	12.[illegible]
3786	5	12.435	11.40[illegible]	1[illegible]	8.565[illegible]	6.87[illegible]
3791	5	.0	4.5750	8.6250	11.775	13.275
3796	5	13.2[illegible]	12.3[illegible]	11.1[illegible]	9.75[illegible]	8.25
38 1	5	.0	3.2250	6.0[illegible]	8.4[illegible]	1[illegible].2[illegible]
38 6	5	11.175	11.175	10.35[illegible]	9.[illegible]	7.5[illegible]
3811	5	.0	2.4750	4.665[illegible]	6.6[illegible]	8.175
3816	5	9.[illegible]15[illegible]	10.[illegible]35	9.9750	8.[illegible]750	7.4250
3821	5	.0	1.9[illegible]0	3.75[illegible]	5.4[illegible]	5.[illegible]
3826	5	7.5[illegible]	7.[illegible]750	7.875[illegible]	7.[illegible]	6.[illegible]
3831	5	.0	.61500	.94500	.82[illegible]	.[illegible]
3836	5	.37500	.26[illegible]	.195[illegible]	.1[illegible]	.135
3841	5	.0	2.1150	2.8[illegible]	2.[illegible]	2.4750
3846	5	2.13[illegible]	1.7650	1.47[illegible]	1.[illegible]65	.735[illegible]
3851	5	.0	3.5250	5.[illegible]	5.115	4.7[illegible]
3856	5	4.23[illegible]	3.5700	2.85[illegible]	2.13[illegible]	1.3[illegible]
3861	5	.0	4.6500	6.75[illegible]	7.1[illegible]	6.75
3866	5	6.[illegible]45[illegible]	5.[illegible]50	4.275	3.[illegible]50	[illegible]
3871	5	.0	5.2[illegible]	6.475[illegible]	5.45	4.[illegible]
3876	5	8.2500	7.3500	6.225[illegible]	4.9[illegible]	3.525
3881	5	.0	5.[illegible]1[illegible]	9.0000	11.13[illegible]	11.4[illegible]
3886	5	10.950	10.[illegible]00	8.8500	7.35[illegible]	5.[illegible]
3891	5	.0	4.5[illegible]	8.625[illegible]	1[illegible].9[illegible]	12.[illegible]30
3896	5	11.7[illegible]	1[illegible].725	[illegible].525[illegible]	[illegible]	[illegible]

3901	5	.0	3.2250	6.0000	8.4000	10.5[illegible]
3906	5	10.425	5.7500	8.5500	7.1250	5.5500
3911	5	.0	2.5500	4.8750	6.7500	8.2500
3916	5	8.8650	8.7000	8.1900	7.3500	6.27[illegible]
3921	5	.0	1.5500	3.7500	5.4[illegible]	6.375[illegible]
3926	5	6.6750	6.6750	6.4500	6.2[illegible]	5.475[illegible]
3931	5	.0	.82500	.97500	.75[illegible]	.48[illegible]
3936	5	.21500	.27000	.15000	.12000	.90060E-01
3941	5	.0	2.6400	3.4950	3.[illegible]	2.37[illegible]
3946	5	1.8000	1.4700	1.1850	.945[illegible]	.75[illegible]
3951	5	.0	4.2000	5.7450	5.3850	4.41[illegible]
3956	5	3.6000	3.6000	2.5200	2.1[illegible]	1.47[illegible]
3961	5	.0	4.9800	7.2150	7.6600	6.2550
3966	5	5.3850	4.6200	3.9750	3.2100	2.145[illegible]
3971	5	.0	5.2500	6.1900	6.71[illegible]	8.25[illegible]
3976	5	7.5750	6.6750	5.6250	4.4250	3.[illegible]75
3981	5	.0	4.9800	8.4[illegible]	9.795[illegible]	5.625[illegible]
3986	5	9.18[illegible]	8.2350	7.0500	5.7750	4.3500
3991	5	.0	4.5750	9.1750	9.9[illegible]	1[illegible].5[illegible]
3996	5	9.3750	8.4000	7.2750	6.[illegible]	4.725[illegible]
4001	5	.0	3.2250	6.0000	8.4000	9.150
4006	5	8.7750	7.8000	6.6000	5.2500	3.825[illegible]
4011	5	.0	2.5500	4.6650	6.45[illegible]	7.3350
4016	5	7.3350	6.8700	6.0750	5.1[illegible]	4.12[illegible]
4021	5	.0	1.9500	3.7500	4.875[illegible]	5.325[illegible]
4026	5	5.3250	5.1750	4.8750	4.3500	3.751[illegible]
4031	5	.0	1.6500	1.1700	.75000	.42[illegible]
4036	5	.24[illegible]	.18000	.12000	.9[illegible]E-01	.75[illegible]E-1
4041	5	.0	3.1500	4.1250	3.3[illegible]	2.325[illegible]
4046	5	1.8000	1.4400	1.1250	.855[illegible]	.735[illegible]
4051	5	.0	4.5750	6.4500	5.925[illegible]	4.725
4056	5	3.4500	2.7750	2.1750	1.8750	1.53[illegible]
4061	5	.0	5.4000	7.5750	7.425[illegible]	6.22[illegible]
4066	5	4.8750	3.9750	3.6900	3.975[illegible]	2.175[illegible]
4071	5	.0	5.7750	7.6000	8.25[illegible]	7.575[illegible]
4076	5	6.[illegible]75[illegible]	5.2500	4.65[illegible]	3.975[illegible]	2.4[illegible]
4081	5	.0	4.9500	7.5000	8.6250	6.2500
4086	5	7.35[illegible]	6.5250	5.5500	3.9750	3.15[illegible]
4091	5	.0	4.5750	7.3500	8.4[illegible]	6.55[illegible]
4096	5	7.6500	6.7500	5.4750	4.35[illegible]	3.[illegible]
4101	5	.0	3.[illegible]	5.7[illegible]	7.425[illegible]	7.05[illegible]
4106	5	7.125[illegible]	6.7000	4.5000	3.2250	1.8000
4111	5	.0	2.3250	4.1250	5.4[illegible]	5.7[illegible]
4116	5	5.475[illegible]	4.5000	3.3750	2.55[illegible]	1.575[illegible]
4121	5	.0	1.6500	3.6000	5.0250	4.275[illegible]
4126	5	3.690[illegible]	3.[illegible]00	2.475[illegible]	1.475[illegible]	1.[illegible]5
1	5	1.10[illegible]	1.0000	2.0000	1.0000	1.0000
6	4	3.[illegible]	2.[illegible]00	1.0000	5.[illegible]	
12	1	1.[illegible]				
15	1	.0				
17	3	1.[illegible]	2.[illegible]	.0		
22	5	1.0000	40000.	.0	.[illegible]	.
27	5	.0	.45000	250.00	3[illegible]	3.0000
32	3	1.[illegible]562	.0	1.05[illegible]		
35	5	1.3000	2.[illegible]00	3.[illegible]	4.[illegible]	5.
42	5	2.[illegible]	8.[illegible]00	9.0000	63.00[illegible]	1[illegible]
112	5	4.1700	.78660	.15000	.192[illegible]E-1	.555
120	2	.0	.0			
122	4	6.276[illegible]	5.2760	1.007[illegible]	1.325[illegible]	
126	5	23.[illegible]	15.[illegible]00	.4825	2.133[illegible]	.2

135	3	1.5000	.50000	.15000		
139	1	9.2740				
142	4	.0	.0	.0	.0	
146	5	.0	.0	.0	.0	.0
151	1	.0				
152	5	.21190	.21640	.19280	.63810	2.0000
170	1	125.00				
172	2	1.0000	15.000			
175	5	.13970	8.0000	-10.000	.10000	.70000E-01
180	2	.32000	723.51			
191	2	1.5300	.0			
193	2	.87000	.67000			
214	1	.0				
216	1	.0				
217	1	1.8200				
219	1	4.0000				
223	5	2.3000	.93640	.0	.97000	.0
226	1	.93640				
227	4	.0	1.1300	30.800	.94300	
231	3	.0	1.0000	.0		
234	2	2.0000	.0			
236	4	250.00	.0	10.943	1030.0	
241	1	.0				
248	5	2.0000	927.00	6.0000	.15900	.97000
253	1	.0				
254	2	.70000	.50000			
257	2	100.00	4.0000			
261	1	2.0000				
262	2	.0	.60000			
272	2	.80000	.80000			
312	2	1762.0	.43080			
315	1	1.0000				
327	1	1.0000				
2602	3	5622.0	1550.0	5630.0		
2605	3	.0	.0	700.00		
2608	5	.0	.0	.0	.0	.0
2613	3	26.000	30.000	30.000		
2616	5	.50000E-02	.0	75.000	18.000	25.000
2621	1	.0				
2622	4	125.00	2.0800	.40000E-01	.80000	
2626	5	.0	1.0000	.0	.0	2.5000
2631	5	.0	.0	.0	.0	.0
2636	1	.0				
2637	4	44.000	2.2000	61.000	.28600	
2641	5	1.1948	.0	14.200	1.0000	1.0000
2646	5	265.00	3.0000	.0	.0	1.0000
2651	3	.15000	.30000	.0		
2654	5	1.0000	1.2060	1.0000	1.0000	1.0000
2659	5	.85000	.85000	1.0000	.85000	1.0000
2664	1	1.0000				
2665	5	1.0000	1.0000	1.0000	1.0000	.93100
2670	4	1.0000	1.0000	1.0000	1.0000	
347	2	3.0000	3.0000			
349	3	-1.0000	.0	1.0000		
354	3	.0	.50000	1.0000		
361	3	1.0000	1.0000	1.0000		
368	3	1.0000	1.0000	1.0000		
375	3	1.0000	1.0000	1.0000		
401	1	.0				
411	1	.33000E-01				

441	1	.94300	
461	2	2.0000	1.0000
481	2	1.0000	.0
491	1	1.0000	
501	1	30.800	
511	2	.0	.0
522	1	1.0000	
531	2	.25000E-01	.10000
541	2	.94300	.94300
551	2	.50000E-01	.27000
571	1	1.0000	
591	1	1.0000	
611	1	30.800	
621	1	1000.0	
631	1	1.0000	
641	1	4000.0	
651	1	10.943	
661	1	.0	
681	1	.0	
691	1	1000.0	
721	1	1.0000	
741	1	1.0000	
761	1	30.800	
771	1	40.000	
781	1	2.0000	
791	1	200.00	
801	1	10.943	
811	1	.0	
831	1	.0	
841	1	1000.0	
871	1	1.0000	
861	1	170.00	
891	1	.0	
911	1	1.0000	
921	1	1000.0	
931	1	30.800	
941	1	.0	
951	1	1000.0	
961	1	200.00	
971	1	10.943	
981	1	.0	
1001	1	.0	
1011	1	1000.0	
1031	1	.0	
1061	1	.25000	
1071	1	10.943	
1081	1	.75000	
1101	1	.0	
1111	1	.0	
1131	1	.0	
1161	1	-2000.0	
1171	1	.16000E-01	
1181	1	1000.0	
1191	1	1.0000	

VC = 0.400000E+05 VFA = 0.0 VFR = 0.0
VC = 0.400000E+05 VFA = 0.458196E+04 VFR = 0.446758E+04
VG = 0.404080E+05 VFA = 0.479086E+04 VFF = 0.491430E+04

SAMPLE CASE NO. 4 RUN 1 PAGE [illegible]

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM (A-91)

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER

S I Z E D A T A THIS RUN CONVERGED IN [illegible] ITERATIONS

GROSS WEIGHT = [illegible]719. LB

FUSELAGE

LB	LENGTH(BODY+TAILBOOM)	[illegible].1 FT.
LC	LENGTH(CABIN)	27.5 FT.
LF	LENGTH(BODY)	42.[illegible] FT.
LTB	LENGTH(TAILBOOM)	7.2 FT.
XM	FUS. ROTOR LOCATION	2[illegible].7 FT.
WF	WIDTH	8.7 FT.
SF	WETTED AREA	1[illegible].2 SQ. FT.

WING NO WING USED

HOR. TAIL

ARHT	ASPECT RATIO	4.17[illegible]
SHT	AREA	1[illegible]4.1 SQ. FT.
BHT	SPAN	26.[illegible] FT.
CBARHT	MEAN CHORD	[illegible] FT.
LAMBDA H	TAPER RATIO	.[illegible]
(T/C)HT	THICKNESS/CHORD	.1[illegible]
LTH	HOR. TAIL ARM	23.1 FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.[illegible]
SVT	AREA	[illegible]7.3 SQ. FT.
BVT	SPAN	[illegible].3 FT.
CBARVT	MEAN CHORD	[illegible] FT.
LAMBDA VT	TAPER RATIO	0.[illegible]
ZTR	TAIL ROTOR(VERT.) LOCATION	[illegible] FT.
ZETAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	[illegible]
(T/C)VT	THICKNESS/CHORD	.15

MAIN ROTOR PYLON

AR	ASPECT RATIO	.1[illegible]
SCP	WETTED AREA	43.[illegible] SQ. FT.
FFEP	FRONTAL AREA	4.4 SQ. FT.
HPI	HEIGHT	2.[illegible] FT.
CBARCP	MEAN CHORD	[illegible].4 FT.
LAMBDA RP	TAPER RATIO	0.[illegible]
(T/C)R	ROOT THICKNESS/CHORD	.21[illegible]
(T/C)T	TIP THICKNESS/CHORD	.21[illegible]

PRIMARY ENGINE NACELLE

LN	LENGTH	0.0 FT.
DN	MEAN DIAMETER	0. FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	0.0 SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION)

DAR	DIAMETER	6.0 FT.
AF	ACTIVITY FACTOR PER BLADE	100.0
SIGAR	SOLIDITY	0.163
NRA	NO. OF PROPELLERS	2.
NO. BLADES	NO. OF BLADES/PROP	4.
VTIP	TIP SPEED	927. FT./SEC

MAIN ROTOP

DMR	DIAMETER	5[illegible].8 FT.
SIGMR	SOLIDITY	[illegible].14[illegible]
WG/A	DISC LOADING	15.0 LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	[illegible]
NR	NO. OF ROTORS	1.
NO. BLADES	NO. OF BLADES/ROTOR	8.
THETA	BLADE TWIST	-1[illegible].[illegible]0[illegible] DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.100
VTIP	TIP SPEED	7[illegible]0. FT./SEC.

- NO TAIL ROTOR USED

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM H-91

W E I G H T S D A T A IN LBS

MLF		MANEUVER LOAD FACTOR	3.[illegible]		
ULF		ULTIMATE LOAD FACTOR	4.5?0		
PROPULSION GROUP					
	WRRG	TOTAL MAIN ROTOR GROUP	5295.		
K12	WBRF	MAIN ROTOR BLADE (PER ROTOR)		2278.	
K13	WRH	MAIN ROTOR HUB (PER ROTOR)		2154.	
	WBF	BLADE FOLDING (PER ROTOR)		963.	
K[illegible]	WAP	AUXILIARY PROPULSION ROTOR GROUP	[illegible]5.		
	WDS	DRIVE SYSTEM	2[illegible]3.		
K[illegible]	WMDS	MAIN ROTOR DRIVE SYSTEM		2819.	
K2[illegible]	WTRDS	TAIL ROTOR DRIVE SYSTEM		[illegible].	
K17	WAPS	AUXILIARY PROPULSION DRIVE SYSTEM		0.	
K[illegible]	WEP	PRIMARY ENGINES	1167.		
K1[illegible]	WEA	AUXILARY ENGINES	[illegible].		
	WPEI	PRIMARY ENGINE INSTALLATION	3[illegible].		
	WAEI	AUXILIARY ENGINE INSTALLATION	.		
	WFS	FUEL SYSTEM	74[illegible].		
DELTA WP		PROPULSION GROUP WEIGHT INCREMENT	0.		
	WP	TOTAL PROPULSION GROUP WEIGHT			1 [illegible]5.
STRUCTURES GROUP					
K[illegible]	WW	WING	.		
	WTG	TAIL GROUP	221.		
K[illegible]	WHT	HOR. TAIL		221.	
K1A	WTR	TAIL ROTOR		[illegible].	
K[illegible]	WB	FUSELAGE	36[illegible]7.		
K7	WLG	LANDING GEAR	1384.		
	WNG	NOSE GEAR		277.	
	WMG	MAIN GEAR		11[illegible]6.	
	WTES	TOTAL ENGINE SECTION	[illegible].		
	WPES	PRIMARY ENGINE SECTION		.	
	WAES	AUXILIARY ENGINE SECTION		0.	
DELTA WST		STRUCTURE WEIGHT INCREMENT	7[illegible].		
	WST	TOTAL STRUCTURE WEIGHT			[illegible].
FLIGHT CONTROLS GROUP					
	WPFC	PRIMARY FLIGHT CONTROLS	1061.		
	WCC	COCKPIT CONTROLS		11[illegible].	
K1	WRC	MAIN ROTOR CONTROLS		[illegible]26.	
K2	WSC	MAIN ROTOR SYSTEMS CONTROLS		77[illegible].	
K[illegible]	WFW	FIXED WING CONTROLS		2?4.	
	WTM	TILT MECHANISM		[illegible].	
	WSAS	SAS		75.	
	WAFC	AUXILIARY FLIGHT CONTROLS	48[illegible].		
K4	WPCA	AUX. PROPULSION ROTOR CONTROLS		[illegible].	
K[illegible]	WSCA	AUX. PROPULSION ROTOR SYS. CONTROLS		1[illegible]1.	

WMC	MISCELLANEOUS CONTROLS	0.
DELTA WFC	CONTROL WEIGHT INCREMENT	0.
WFC	TOTAL CONTROL WEIGHT	6527.
WFE	WEIGHT OF FIXED EQUIPMENT	5622.
WE	WEIGHT EMPTY	28569.
WFUL	FIXED USEFUL LOAD	1550.
OWE	OPERATING WEIGHT EMPTY	30139.
WPL	PAYLOAD	5030.
(WF)A	FUEL	4550.
WG	GROSS WEIGHT	40719.

SAMPLE CASE NO. 4 RUN 1 PAGE 4

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-51

R O T O R D A T A

FIXED MAIN ROTOR SOLIDITY INPUT

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                                   H E S C O M P
                HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    B-91


P R O P U L S I O N   D A T A
        PRIMARY PROPULSION CYCLE NO.    1.820
              TURBOSHAFT ENGINE

              4.  ENGINES

           EHP*P          MAX. STANDARD S.L. STATIC H.P.          8617.     H.P.

           ENGINE SIZED FOR TAKEOFF AT T/W =1.13
           100.0 PERCENT MILITARY POWER SETTING,
           H =    0. FT, TEMPERATURE = 89.80 DEG.F.,
            0.0   ENGINES INOPERATIVE, AND     0.   FT/MIN VERTICAL RATE OF CLIMB.

           NO CRUISE CONDITION SPECIFIED.


        NO AUX. INDEPENDENT ENGINE CYCLE SELECTED


             MAIN ROTOR DRIVE SYSTEM RATING          6810.     H.P.

        XMSN SIZED AT  94. PERCENT OF MAIN ROTOR HOVER POWER REQUIRED
        AT H =    0. FT, TEMP = 89.80 DEG.F., 100.0 PERCENT HOVER RPM

             AUXILIARY PROPULSION DRIVE SYSTEM RATING          681 .     H.P.

        XMSN SIZED AT  94. PERCENT OF TOTAL CONFIGURATION POWER REQUIRED TO HOVER
        AT H=    0. FT, TEMP = 89.80  DEG.F., 100.0 PERCENT HOVER RPM
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                                   H E S C O M P
               HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    8-91

 A E R O D Y N A M I C S   D A T A
        FE              TOTAL EFFECTIVE FLATPLATE AREA           22.376      SQFT
        SWET            TOTAL WETTED AREA                         1435.      SQFT
        CPARF           MEAN SKIN FRICTION COEFF.              0.015942
     D R A G   B R E A K D O W N             IN  SQFT
        FEW             WING FE                                              0.0
        FEF             FUSELAGE FE                                          22.376
        FEFP            FORWARD(MAIN) ROTOR PYLON FE                         0.0
        FEAP            AFT ROTOR PYLON FE                                   0.0
        FEMRH           MAIN ROTOR HUB(S) FE                                 0.0
        FETRH           TAIL ROTOR HUB FE                                    0.0
        FEVT            VERTICAL TAIL FE                                     0.0
        FEHT            HORIZONTAL TAIL FE                                   0.0
        FEN             PRIMARY ENGINE NACELLE FE                            0.0
        FEGI            AUX. INDEPENDENT CRUISE ENG. NAC. FE                 0.0
        FENS            AUX. INDEPENDENT CRUISE ENG. STRUT FE                0.0
        DELTA FE        INCREMENTAL FE
 A E R O D Y N A M I C   C O E F F .
        AF                                                               22.47634
        AC                                                                0.0
        AT                                                                0.0
        A                                                                 0.0
        AO                                                                1.24195
        E         WING LIFT EFFICIENCY FACTOR                        0.0
        EVT       VERTICAL TAIL LIFT EFFICIENCY FACTOR               0.FF 71
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-91

MISSION PERFORMANCE DATA

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRESS. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	AUX. TURB. TEMP. (R)	AUX. ENG. CODE	AUX. ENG. PEHF	AUX. ENG. FUEL FLOW (LBS/HR)	TEMP. DEG. (F)
0.0	0.0	0.0	40719.	0.	0.0	1750.0	T	0.0	1000.	----	----	----		59.0
0.033	0.0	33.0	40686.	0.	0.0	1750.0	T	0.0	1000.	----	----	----		59.0

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR 0.150 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	RHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPERO	CPIND	CDI
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.033	0.0	33.0	40686.	0.	0.0	2639.3	T	1.1[illegible]	3722.	1.129	0.729	7257.	0.0154	0.110
700.0	7139.	0.0	0.	0.	3722.		A		89.8	[illegible]	0.729	0.[illegible]	[illegible]	.[illegible]
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.058	0.0	126.1	40593.	0.	0.0	2639.3	T	1.000	3722.	1.129	0.729	7234.	0.0154	0.110
700.0	7017.	0.0	[illegible]	0.	3722.		A		89.8	[illegible]	0.729	0.[illegible]	[illegible]	.[illegible]
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.083	0.0	219.1	40500.	0.	0.0	2639.3	T	1.000	3722.	1.129	0.728	7210.	[illegible].153	0.11[illegible]
700.0	6994.	0.0	0.	0.	3722.		A		89.8	0.0	0.728	0.[illegible]	[illegible]	.[illegible]

CLIMB TO 4000. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	RHP	R/C (FPM)
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP	T.ROTOR RHP	PROP VTIP	PRIM.ENG FUEL FLOW	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. RPM OR THRUST	

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(FPS)            (FPS)              (FPS)  (LBS/HR)                         (LBS/HR)

CPPRO   CPIND    CPPAR    CPNUD    CDO     DELCDS   DELCDP   CXR      ROTLIM   J      CP     CT     CLW    CDW    RN
                                                                      CODE

                                                    77.1   2645.0     T        1.000    74.9   0.188  0.101  -0.6   27.0   7354. 4029.
0.083       0.0   219.1    40500.      0.          3763.      0.   0.700     0.0      ----   ----   ----   ----          ----
700.0     1431.     0.0        0.    ----     0.0        0.0     0.000149     A        ----   ----   ----   ----   ----   ----
0.0     0.0      0.0      0.0      0.0

                                                    78.1   2645.0     T        1.000    74.7   0.191  0.104  -0.6   26.2   7236. 3943.
0.087       0.32  234.7    40484.   1060.          3687.      0.   0.700     0.0      ----   ----   ----   ----          ----
700.0     1454.     0.0        0.    ----     0.0        0.0     0.000153     A        ----   ----   ----   ----   ----   ----
0.0     0.0      0.0      0.0      0.0

                                                    79.1   2645.0     T        1.000    74.6   0.193  0.107  -0.6   25.4   7121. 3850.
0.091       0.66  250.3    40469.   2000.          3611.      0.   0.700     0.0      ----   ----   ----   ----          ----
700.0     1480.     0.0        0.    ----     0.0        0.0     0.000157     A        ----   ----   ----   ----   ----   ----
0.0     0.0      0.0      0.0      0.0

                                                    81.1   2645.0     T        1.000    75.3   0.198  0.110  -0.6   24.3   7007. 3755.
0.096       1.00  265.9    40453.   3000.          3535.      0.   0.700     0.0      ----   ----   ----   ----          ----
700.0     1510.     0.0        0.    ----     0.0        0.0     0.000165     A        ----   ----   ----   ----   ----   ----
0.0     0.0      0.0      0.0      0.0

                                                    82.1   2645.0     T        1.000    75.1   0.200  0.114  -0.6   23.4   6888. 3649.
0.100       1.37  281.6    40437.   4000.          3458.      0.   0.700     0.0      ----   ----   ----   ----          ----
700.0     1541.     0.0        0.    ----     0.0        0.0     0.000169     A        ----   ----   ----   ----   ----   ----
0.0     0.0      0.0      0.0      0.0
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CRUISE AT NORMAL ENGINE RATING

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TIME     RANGE    FUEL     WEIGHT   PRES.   TAS      PRIM.    PRIM.    PRIM.    EAS      MU      CT PRIME  ALPHA   SPEC.    RHP
(HRS)    (N.M.)   USED     (LBS.)   ALT.    (KTS)    TURB.    ENG.     ENG.     (KTS)            OVER      D/L     RANGE
                  (LBS)             (FT)             TEMP.    CODE     PFHF                      SIGMA     (DEG)   (NMPP)
                                                     (R)
                                                                                         AUX.    AUX.      AUX.             AUX.
M.ROTOR  M.ROTOR  T.ROTOR  T.ROTOR  PROP    PRIM.ENG RHP      ETAP     TAUX/T   AUX. ENG. TURB.  ENG.      ENG.             ENG. BHP
VTIP     RHP      VTIP     RHP      VTIP    FUEL FLOW AUX     PROP              FUEL FLOW TEMP.  CODE      PEMF             OR THRUST
(FPS)             (FPS)             (FPS)   (LBS/HR)                            (LBS/HR)

CPPRO   CPIND    CPPAR    CPNUD    CDO     DELCDS   DELCDP   CXP      ROTLIM   J      CP     CT     CLW    CDW     RN
                                                                      CODE

                                                   222.2   2522.0     T        0.839  203.3  0.596  0.135  -1.9   .07348   5778.
0.100       1.37  281.6    40437.   4000.          3028.   1662.   0.800     0.594    ----   ----   ----   ----           ----
629.9     3993.     0.0        0.    ----     0.0        0.0     0.000612     A        ----   ----   ----   ----   ----    ----
0.0     0.0      0.0      0.0      0.0

                                                   223.0   2522.0     T        0.839  204.1  0.599  0.134  -1.9   .07367   5775.
0.280      41.37  826.6    39892.   4000.          3028.   1690.   0.800     0.594    ----   ----   ----   ----           ----
628.5     3962.     0.0        0.    ----     0.0        0.0     0.000614     A        ----   ----   ----   ----   ----    ----
0.0     0.0      0.0      0.0      0.0

                                                   223.6   2522.0     T        0.839  204.8  0.603  0.133  -1.9   .07393   5773.
0.459      81.37 1369.5    39349.   4000.          3028.   1719.   0.800     0.594    ----   ----   ----   ----           ----
627.0     3933.     0.0        0.    ----     0.0        0.0     0.000616     A        ----   ----   ----   ----   ----    ----
0.0     0.0      0.0      0.0      0.0

                                                   224.6   2522.0     T        0.839  205.5  0.606  0.131  -1.9   .07418   5772.
0.638     121.37 1910.6    38808.   4000.          3028.   1747.   0.800     0.594    ----   ----   ----   ----           ----
625.6     3903.     0.0        0.    ----     0.0        0.0     0.000617     A        ----   ----   ----   ----   ----    ----
0.0     0.0      0.0      0.0      0.0
```

0.816	161.37	2449.8	38269.	4000.	225.4	2522.0	T	0.839	206.2	0.610	0.136	-1.9	.07443		577.
624.2	3875.	0.6	0.	----	3028.	1776.	0.800	0.594	----	----	----	----			----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000619	A	----	----	----	----	----		----
0.937	188.69	2816.8	37902.	4000.	225.9	2522.0	T	0.849	206.7	0.612	0.129	-2.0	.07460		769.
623.3	3855.	0.0	0.	----	3028.	1795.	0.800	0.607	----	----	----	----			----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000620	A	----	----	----	----	----		----

DESCEND TO H = 0. FT. ,R = 200.00 N.MI. AT CONSTANT TAS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	BHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RMP	T.ROTOR VTIP (FPS)	T.ROTOR RMP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHF AUX	[illegible]	[illegible]	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF	AUX. ENG. BHP OR THRUST		
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	AN	
0.937	188.69	2816.8	37902.	4000.	170.0	1800.0	T	0.076	155.5	0.410	0.102	3.5	-3.3	55[illegible].	1[illegible] .
700.0	514.	0.0	0.	----	860.	0.	0.500	1.551	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.000872	A	----	----	----	----	----	----	
0.954	191.51	2831.2	37888.	3000.	170.0	1800.0	T	0.079	155.5	0.410	0.102	3.4	-3.3	550.	1[illegible] .
700.0	534.	0.0	0.	----	860.	0.	0.500	1.542	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.000858	A	----	----	----	----	----	----	
0.971	194.34	2845.5	37873.	2000.	170.0	1800.0	T	0.079	155.5	0.410	0.102	3.4	-3.3	55[illegible].	1[illegible] .
700.0	534.	0.0	0.	----	860.	0.	0.500	1.542	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.000857	A	----	----	----	----	----	----	
0.987	197.17	2859.8	37859.	1000.	170.0	1800.0	T	0.079	155.5	0.410	0.102	3.4	-3.3	550.	1[illegible] .
700.0	534.	0.0	0.	----	860.	0.	0.500	1.542	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.000857	A	----	----	----	----	----	----	
1.004	200.00	2874.2	37845.	0.	170.0	1800.0	T	0.079	155.5	0.410	0.102	3.4	-3.3	550.	1[illegible] .
700.0	533.	0.0	0.	----	860.	0.	0.500	1.541	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.000857	A	----	----	----	----	----	----	

TAKEOFF, HOVER, OR LAND AT T/W = 1.03 FOR 0.200 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FP	BHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RMP	T.ROTOR VTIP (FPS)	T.ROTOR RMP	VRC RMP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FPI	CPFRU	CPIND	CP
1.004	200.00	2874.2	37845.	0.	0.0	2380.6	F	0.655	3132.	1.030	0.7[illegible]8	5667.	.0123	.

700.0	5497.	0.0	0.	0.	3132.	----	A		59.0	0.0	0.788	0.0	0.0	0.0
1.104	200.00	3187.4	37532.	0.	0.0	2374.9	P	0.651	3109.	1.030	0.788	5604.	0.0122	0.000
700.0	5436.	0.0	0.	0.	3109.	----	A		59.0	0.0	0.788	0.0	0.0	0.0
1.204	200.00	3498.3	37221.	0.	0.0	2369.2	P	0.644	3086.	1.030	0.787	5541.	0.0121	0.087
700.0	5375.	0.0	0.	0.	3086.	----	A		59.0	0.0	0.787	0.0	0.0	0.0

CHANGE PAYLOAD. REMOVE 2000. LB.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.204	200.00	3498.3	37221.	0.
1.214	200.00	3498.3	35221.	0.

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.214	200.00	3498.3	35221.	0.
1.214	200.00	3498.3	35221.	1000.

LOITER FOR 0.750 HRS. FOR RESERVE FUEL

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	BHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
1.214	200.00	3498.3	35221.	1000.	68.7	1964.9	P	0.175	67.7	0.166	0.086	5.0	1593.	1487.
700.0	513.	0.0	0.	----	1593.	958.	0.800	9.929	----	----	----	----	----	----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.001032	A	----	----	----	----		----
1.464	200.00	3896.5	34822.	1000.	68.7	1957.7	P	0.172	67.7	0.166	0.085	5.0	1584.	1462.
700.0	499.	0.0	0.	----	1584.	948.	0.800	9.824	----	----	----	----	----	----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.001020	A	----	----	----	----		----
1.714	200.00	4292.6	34426.	1000.	67.7	1954.6	P	0.169	66.7	0.163	0.084	5.0	1576.	1436.
700.0	499.	0.0	0.	----	1576.	922.	0.800	9.989	----	----	----	----	----	----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.001009	A	----	----	----	----		----
1.964	200.00	4686.6	34032.	1000.	67.7	1951.4	P	0.166	66.7	0.163	0.083	5.0	1568.	1412.
700.0	484.	0.0	0.	----	1568.	912.	0.800	9.883	----	----	----	----	----	----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	-.000997	A	----	----	----	----		----

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MISSION FUEL REQUIRED =  3498.29
RESERVE FUEL REQUIRED =  1451.75
TOTAL   FUEL REQUIRED =  4950.04

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END  OF  SUCCESSFUL  CASE

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                                H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    B-91

        THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

 LOC.   CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
 NUM    STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
 VAL    EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
 VAL1          VALUE              CORRESPONDING TO LOC.+0001
 VAL2          VALUE              CORRESPONDING TO LOC.+0002
        ETC.

  LOC.      NUM       VAL          VAL1          VAL2          VAL3          VAL4

        NOTE : IN USING AUXILIARY ENGINES & AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED
        BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

       9       1       6.0000
 WG = 0.400000E+05  WFA = 0.495004E+04  WFR = 0.495004E+04
 WG = 0.400000E+05  WFA = 0.458196E+04  WFR = 0.493387E+04
 WG = 0.405027E+05  WFA = 0.483934E+04  WFR = 0.499233E+04
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H F S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM R-91

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 40889. LB

FUSELAGE

LF	LENGTH(BODY+TAILBOOM)	50.1 FT.
LC	LENGTH(CABIN)	23.5 FT.
LB	LENGTH(BODY)	42.8 FT.
LTB	LENGTH(TAILBOOM)	7.3 FT.
XM	FWD. ROTOR LOCATION	29.7 FT.
WF	WIDTH	8.3 FT.
SF	WETTED AREA	1069.3 SQ. FT.

WING - NO WING USED

HOR. TAIL

ARHT	ASPECT RATIO	4.178
SHT	AREA	104.5 SQ. FT.
BHT	SPAN	20.9 FT.
CBARHT	MEAN CHORD	5.0 FT.
LAMBDA H	TAPER RATIO	0.555
(T/C)HT	THICKNESS/CHORD	0.150
LTH	HOR. TAIL ARM	23.2 FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.500
SVT	AREA	57.3 SQ. FT.
BVT	SPAN	9.3 FT.
CBARVT	MEAN CHORD	6.2 FT.
LAMBDA VT	TAPER RATIO	0.500
ZTR	TAIL ROTOR(VERT.) LOCATION	0.0 FT.
ZETAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	0.0
(T/C)VT	THICKNESS/CHORD	0.151

MAIN ROTOR PYLON

AR	ASPECT RATIO	0.193
SFP	WETTED AREA	43.6 SQ. FT.
FAFP	FRONTAL AREA	4.4 SQ. FT.
HP1	HEIGHT	2.0 FT.
CBARFP	MEAN CHORD	10.4 FT.
LAMBDA FP	TAPER RATIO	0.638
(T/C)R	ROOT THICKNESS/CHORD	0.212
(T/C)T	TIP THICKNESS/CHORD	0.216

PRIMARY ENGINE NACELLE

LN	LENGTH	0.0	FT.
DN	MEAN DIAMETER	0.	FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	0.0	SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION)

DAR	DIAMETER	6.0	FT.
AF	ACTIVITY FACTOR PER BLADE	100.0	
SIGAR	SOLIDITY	0.163	
NRA	NO. OF PROPELLERS	2.	
NO. BLADES	NO. OF BLADES/PROP	4.	
VTIP	TIP SPEED	927.	FT./SEC

MAIN ROTOR

DMR	DIAMETER	58.9	FT.
SIGMR	SOLIDITY	0.140	
WG/A	DISC LOADING	15.0	LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.0	
NR	NO. OF ROTORS	1.	
NO. BLADES	NO. OF BLADES/ROTOR	8.	
THETA	BLADE TWIST	-10.000	DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.100	
VTIP	TIP SPEED	700.	FT./SEC.

- NO TAIL ROTOR USED

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SAMPLE CASE NO. 4   RUN 2                                                    PAGE   3

                                     H E S C O M P
                   HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    B-91


   W E I G H T S   D A T A     IN LBS

          MLF            MANEUVER LOAD FACTOR                         3.000
          ULF            ULTIMATE LOAD FACTOR                         4.500

      PROPULSION GROUP
              WPRG       TOTAL MAIN ROTOR GROUP                        5321.
          K12 WPRB           MAIN ROTOR BLADE (PER ROTOR)                  2290.
          K13 WPH            MAIN ROTOR HUB (PER ROTOR)                    2163.
              WBF            BLADE FOLDING(PER ROTOR)                       867.
          K15 WAR        AUXILIARY PROPULSION ROTOR GROUP               265.
              WDS        DRIVE SYSTEM                                  2991.
          K16 WPDS           MAIN ROTOR DRIVE SYSTEM                       2991.
          K26 WTRDS          TAIL ROTOR DRIVE SYSTEM                          0.
          K17 WADS           AUXILIARY PROPULSION DRIVE SYSTEM                0.
          K18 WEP        PRIMARY ENGINES                               1191.
          K19 WEA        AUXILARY ENGINES                                 0.
              WPEI       PRIMARY ENGINE INSTALLATION                    357.
              WAEI       AUXILIARY ENGINE INSTALLATION                    0.
              WFS        FUEL SYSTEM                                    756.
          DELTA WP       PROPULSION GROUP WEIGHT INCREMENT                0.
                WP   TOTAL PROPULSION GROUP WEIGHT                                    10791.

      STRUCTURES GROUP
          K8  WW         WING                                             0.
              WTG        TAIL GROUP                                     222.
          K9  WHT            HOR. TAIL                                      222.
          K14 WTR            TAIL ROTOR                                       0.
          K6  WB         FUSELAGE                                      3614.
          K7  WLG        LANDING GEAR                                  1390.
              WNG            NOSE GEAR                                      278.
              WMG            MAIN GEAR                                     1112.
              WTES       TOTAL ENGINE SECTION                             0.
              WPES           PRIMARY ENGINE SECTION                           0.
              WAES           AUXILIARY ENGINE SECTION                         0.
          DELTA WST      STRUCTURE WEIGHT INCREMENT                     700.
                WST  TOTAL STRUCTURE WEIGHT                                            5718.

      FLIGHT CONTROLS GROUP
              WPFC       PRIMARY FLIGHT CONTROLS                       1669.
              WCC            COCKPIT CONTROLS                               119.
          K1  WRC            MAIN ROTOR CONTROLS                            529.
          K2  WSC            MAIN ROTOR SYSTEMS CONTROLS                    741.
          K3  WFW            FIXED WING CONTROLS                            204.
              WTM            TILT MECHANISM                                   0.
              WSAS           SAS                                             75.
              WAFC       AUXILIARY FLIGHT CONTROLS                     4673.
          K4  WPCA           AUX. PROPULSION ROTOR CONTROLS                4771.
          K5  WSCA           AUX. PROPULSION ROTOR SYS. CONTROLS            1[illegible]1.
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WMC	MISCELLANEOUS CONTROLS	0.	
DELTA WFC	CONTROL WEIGHT INCREMENT	0.	
WFC	TOTAL CONTROL WEIGHT		6542.
WFE	WEIGHT OF FIXED EQUIPMENT		5622.
WE	WEIGHT EMPTY		28672.
WFUL	FIXED USEFUL LOAD		1550.
OWE	OPERATING WEIGHT EMPTY		30222.
WPL	PAYLOAD		5630.
(WF)A	FUEL		5037.
WG	GROSS WEIGHT		40889.

SAMPLE CASE NO. 4   RUN 2   PAGE 4

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

R O T O R   D A T A

FIXED MAIN ROTOR SOLIDITY INPUT

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                              H E S C O M P
           HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    H-91


  P R O P U L S I O N   D A T A
          PRIMARY PROPULSION CYCLE NO.     1.820
                 TURBOSHAFT ENGINE

                  4.  ENGINES

             BHP*P          MAX. STANDARD S.L. STATIC H.P.          8653.     H.P.

             ENGINE SIZED FOR TAKEOFF AT T/W =1.13
             100.0 PERCENT MILITARY POWER SETTING,
             H =     0. FT, TEMPERATURE = 89.80 DEG.F.,
              0.0   ENGINES INOPERATIVE, AND     0.0  FT/MIN VERTICAL RATE OF CLIMB.

             NO CRUISE CONDITION SPECIFIED.


          NO AUX. INDEPENDENT ENGINE CYCLE SELECTED


                 MAIN ROTOR DRIVE SYSTEM RATING          6838.     H.P.

          XMSN SIZED AT  94. PERCENT OF MAIN ROTOR HOVER POWER REQUIRED
          AT H =     0. FT, TEMP = 89.80 DEG.F., 100.0 PERCENT HOVER RPM

                 AUXILIARY PROPULSION DRIVE SYSTEM RATING          6638.     H.P.

          XMSN SIZED AT  94. PERCENT OF TOTAL CONFIGURATION POWER REQUIRED TO HOVER
          AT H=     0. FT, TEMP = 89.80  DEG.F., 100.0 PERCENT HOVER RPM
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

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A E R O D Y N A M I C S   D A T A
          FE           TOTAL EFFECTIVE FLATPLATE AREA          22.918     SQFT
          SWET         TOTAL WETTED AREA                        1437.     SQFT
          CBARF        MEAN SKIN FRICTION COEFF.             0.015948
       D R A G   B R E A K D O W N         IN  SQFT
          FFW          WING FE                                       0.0
          FFF          FUSELAGE FE                                 22.918
          FEFP         FORWARD(MAIN) ROTOR PYLON FE                  0.0
          FEAP         AFT ROTOR PYLON FE                            0.0
          FEMRH        MAIN ROTOR HUB(S) FE                          0.0
          FETRH        TAIL ROTOR HUB FE                             0.0
          FEVT         VERTICAL TAIL FE                              0.0
          FEHT         HORIZONTAL TAIL FE                            0.0
          FEN          PRIMARY ENGINE NACELLE FE                     0.0
          FENI         AUX. INDEPENDENT CRUISE ENG. NAC. FE          0.0
          FENS         AUX. INDEPENDENT CRUISE ENG. STRUT FE         0.0
          DELTA FE     INCREMENTAL FE                                0.0
A E R O D Y N A M I C   C O E F F .
          A5                                                   22.91754
          A6                                                     0.0
          A7                                                     0.0
          A8                                                     0.0
          A9                                                     0.24395
          E        WING LIFT EFFICIENCY FACTOR                0.0
          EVT      VERTICAL TAIL LIFT EFFICIENCY FACTOR       0.88971
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SAMPLE CASE NO. 4   RUN 2   PAGE 7

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   B-91

MISSION PERFORMANCE DATA

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRESS. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	AUX. TURB. TEMP. (R)	AUX. ENG. CODE	AUX. ENG. PEHF	AUX. ENG. FUEL FLOW (LBS/HR)	TEMP. DEG. (F)
0.0	0.0	0.0	40889.	0.	0.0	1750.0	T	0.0	1004.	----	----	----		59.0
0.033	0.0	33.1	40856.	0.	0.0	1750.0	T	0.0	1004.	----	----	----		59.0

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR 0.050 HRS.

TIME (HRS) / M.ROTOR VTIP	RANGE (N.M.) / M.ROTOR RHP	FUEL USED (LBS) / T.ROTOR VTIP (FPS)	WEIGHT (LBS.) / T.ROTOR RHP	PRES. ALT. (FT) / VRC RHP	TAS (KTS) / PRIM.ENG FUEL FLOW (LBS/HR)	PRIM. TURB. TEMP. (R) / AUX.ENG FUEL FLOW (LBS/HR)	PRIM. ENG. CODE / ROTLIM CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR) / TEMP DEG. (F)	THRUST TO WEIGHT / DELDCM	FM / FMI	BHP / CPPRO	CT / CPIND	CT/SIGMA / CDO
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.033	0.0	33.1	40856.	0.	0.0	2639.3	T	1.000	3738.	1.129	0.729	7287.	0.0154	0.116
700.0	7068.	0.0	0.	0.	3738.		A		89.8	0.0	0.729	0.0	0.0	0.0
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.058	0.0	126.6	40763.	0.	0.0	2639.3	T	1.000	3738.	1.129	0.729	7264.	0.0154	0.116
700.0	7046.	0.0	0.	0.	3738.		A		89.8	0.0	0.729	0.0	0.0	0.0
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.083	0.0	220.0	40669.	0.	0.0	2639.3	T	1.000	3738.	1.129	0.728	7241.	0.0152	0.116
700.0	7023.	0.0	0.	0.	3738.		A		89.8	0.0	0.728	0.0	0.0	0.0

CLIMB TO 4000. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS) / M.ROTOR VTIP	RANGE (N.M.) / M.ROTOR RHP	FUEL USED (LBS) / T.ROTOR VTIP	WEIGHT (LBS.) / T.ROTOR RHP	PRES. ALT. (FT) / PROP VTIP	TAS (KTS) / PRIM.ENG FUEL FLOW	PRIM. TURB. TEMP. (R) / BHP AUX	PRIM. ENG. CODE / ETAP PROP	PRIM. ENG. PEHF / TAUX/T	EAS (KTS) / AUX. ENG. FUEL FLOW	MU / AUX. TURB. TEMP.	CT PRIME OVER SIGMA / AUX. ENG. CODE	ALPHA D/L (DEG) / AUX. ENG. PEHF	GAMMA (DEG)	BHP / AUX. ENG. BHP OR THRUST	R/C (FPM)

CPPRO (FPS)	CPIND	CPPAR (FPS)	CPNUD	CDO (FPS)	DELCDS (LBS/HR)	DELCOM	CXR	ROTLIM CODE	J (LBS/HR)	CP	CT	CLW	CDW	RN	
0.083	0.0	220.0	40669.	0.	77.1	2645.0	T	1.000	74.9	0.188	0.101	-0.6	27.0	7365.	4029.
700.0	1437.	0.0	0.	----	3778.	0.	0.703	0.0	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000149	A	----	----	----	----	----	----	
0.087	0.32	235.7	40654.	1000.	78.1	2645.0	T	1.000	74.8	0.191	0.104	-0.6	26.2	7261.	3942.
700.0	1460.	0.0	0.	----	3703.	0.	0.700	0.0	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000153	A	----	----	----	----	----	----	
0.091	0.66	251.3	40636.	2000.	79.1	2645.0	T	1.000	74.6	0.193	0.107	-0.6	25.4	7150.	3851.
700.0	1486.	0.0	0.	----	3627.	0.	0.700	0.0	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000157	A	----	----	----	----	----	----	
0.096	1.01	267.0	40622.	3000.	81.1	2645.0	T	1.000	75.4	0.196	0.110	-0.6	24.3	7036.	3753.
700.0	1516.	0.0	0.	----	3550.	0.	0.700	0.0	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000165	A	----	----	----	----	----	----	
0.100	1.37	282.8	40607.	4000.	82.1	2645.0	T	1.000	75.1	0.200	0.114	-0.6	23.4	6917.	3649.
700.0	1548.	0.0	0.	----	3473.	0.	0.700	0.0	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000169	A	----	----	----	----	----	----	

CRUISE AT NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PCHP	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	PHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	PHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PCHP		AUX. ENG. EHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCOM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
0.100	1.37	282.8	40697.	4100.	222.3	2522.0	T	0.839	203.4	.596	0.135	-1.9	.07313	[illegible]
629.7	4010.	0.0	0.	----	3040.	1669.	0.800	0.595	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000611	A	----	----	----	----	----	----
0.280	41.37	829.7	40068.	4100.	223.2	2522.0	T	0.839	204.2	.600	0.134	-1.9	.07339	5795.
628.3	3979.	0.0	0.	----	3040.	1697.	0.800	0.595	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000613	A	----	----	----	----	----	----
0.459	81.37	1374.8	39515.	4100.	223.5	2522.0	T	0.839	204.9	0.603	0.133	-1.9	.07365	5797.
626.8	3945.	0.0	0.	----	3041.	1726.	0.800	0.595	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000614	A	----	----	----	----	----	----
0.638	121.37	1917.8	38972.	4100.	224.7	2522.0	T	0.839	205.6	0.607	0.132	-1.9	.07351	5755.
625.4	3920.	0.0	0.	----	3041.	1755.	0.800	0.595	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000616	A	----	----	----	----	----	----

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	BHP	R/S (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. BHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDP	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN	
0.816	161.37	2459.0	38430.	4000.	225.5	2522.0	T	0.839	206.3	0.610	0.130	-1.9	.07416		5794.
624.0	3891.	0.0	0.	----	3041.	1783.	0.800	0.595	----	----	----	----			----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000618	A	----	----	----	----	----		----
0.937	168.69	2827.4	38062.	4000.	226.0	2522.0	T	0.840	206.8	0.612	0.129	-2.0	.07433		5793.
623.1	3871.	0.0	0.	----	3041.	1802.	0.800	0.607	----	----	----	----			----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000619	A	----	----	----	----	----		----

DESCEND TO H = 0. FT. ,R = 200.00 N.MI. AT CONSTANT TAS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	BHP	R/S (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEMF		AUX. ENG. BHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDP	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN	
0.937	188.69	2827.4	38062.	4000.	170.0	2232.9	P	0.423	155.5	0.410	0.102	-2.7	-3.3	2947.	1000.
700.0	2858.	0.0	0.	----	1992.	0.	0.800	0.575	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000672	A	----	----	----	----	----	----	
0.954	191.51	2860.6	38029.	3000.	170.0	2232.6	P	0.422	155.5	0.413	0.102	-2.7	-3.3	2944.	1000.
700.0	2855.	0.0	0.	----	1991.	0.	0.800	0.575	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000671	A	----	----	----	----	----	----	
0.970	194.34	2893.8	37996.	2000.	170.0	2232.3	P	0.422	155.5	0.416	0.102	-2.7	-3.3	2940.	1000.
700.0	2852.	0.0	0.	----	1990.	0.	0.800	0.576	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000671	A	----	----	----	----	----	----	
0.987	197.17	2926.9	37962.	1000.	170.0	2232.0	P	0.422	155.5	0.41[illegible]	0.102	-2.7	-3.3	2937.	1000.
700.0	2849.	0.0	0.	----	1989.	0.	0.800	0.576	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000670	A	----	----	----	----	----	----	
1.004	200.00	2960.1	37929.	0.	170.0	2231.6	P	0.421	155.5	0.410	0.102	-2.7	-3.3	2934.	1000.
700.0	2846.	0.0	0.	----	1988.	0.	0.800	0.576	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000670	A	----	----	----	----	----	----	

TAKEOFF, HOVER, OR LAND AT T/W = 1.030 FOR 0.200 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEMF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	HHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELOCH	FMI	CPERO	CPIND	CDO
1.004	200.00	2960.1	37929.	0.	0.0	2779.2	P	0.657	3140.	1.036	0.769	5676.	.0123	[illegible]

700.0	5506.	0.0	0.	0.	3140.	----	A		59.0	0.0	0.708	0.0	0.0	0.0
1.104	200.00	3274.1	37615.	0.	0.0	2373.5	P	0.650	3116.	1.030	0.707	5613.	0.0122	0.087
700.0	5444.	0.0	0.	0.	3116.	----	A		59.0	0.0	0.707	0.0	0.0	0.0
1.204	200.00	3585.7	37304.	0.	0.0	2367.9	P	0.642	3093.	1.030	0.707	5550.	0.0121	0.087
700.0	5383.	0.0	0.	0.	3093.	----	A		59.0	0.0	0.707	0.0	0.0	0.0

CHANGE PAYLOAD, REMOVE 2081. LB.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.204	200.00	3585.7	37304.	0.
1.214	200.00	3585.7	35304.	0.

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.214	200.00	3585.7	35304.	0.
1.214	200.00	3585.7	35304.	1000.

LOITER FOR 0.75 HRS. FOR RESERVE FUEL

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (K)	PRIM. ENG. CODE	PRIM. ENG. PCHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	BHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAF PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PCHF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CFPAR	CPMUD	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
1.214	200.00	3585.7	35304.	1000.	71.7	1956.	P	0.171	70.7	0.173	0.185	-0.6	1567.	1454.
700.0	1409.	0.0	0.	----	1567.	2.	0.800	0.019	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000123	A	----	----	----	----	----	----
1.464	200.00	3982.4	34907.	1000.	76.7	1952.4	P	0.167	75.6	0.185	0.084	-0.7	1577.	1426.
700.0	1381.	0.0	0.	----	1577.	2.	0.800	0.015	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000142	A	----	----	----	----	----	----
1.714	200.00	4376.7	34513.	1000.	70.7	1945.9	P	0.165	69.7	0.172	0.083	-0.6	1570.	1406.
700.0	1362.	0.0	0.	----	1570.	2.	0.800	0.020	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000120	A	----	----	----	----	----	----
1.964	200.00	4769.2	34120.	1000.	70.7	1946.8	P	0.162	69.7	0.170	0.082	-0.6	1562.	1381.
700.0	1338.	0.0	0.	----	1562.	2.	0.800	0.019	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000120	A	----	----	----	----	----	----

```
MISSION FUEL REQUIRED =  3585.71
RESERVE FUEL REQUIRED =  1451.53
TOTAL   FUEL REQUIRED =  5037.25

**************************************************************************************************************

END  OF  SUCCESSFUL  CASE

**************************************************************************************************************


SAMPLE CASE NO. 4   RUN 3                                                    PAGE   1

                                        H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    8-81

       THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE .

 LOC.  CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
 NUM   STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
 VAL   EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
 VAL1         VALUE              CORRESPONDING TO LOC.+0001
 VAL2         VALUE              CORRESPONDING TO LOC.+0002
       ETC.

   LOC.      NUM        VAL            VAL1            VAL2            VAL3            VAL4

       NOTE : IN USING AUXILIARY ENGINES : AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED
       BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

    238       2         20.943          2000.0
    691       1         2000.0
    801       1         20.943
    841       1         2000.0
    971       1         20.943
   1011       1         2000.0
   1071       1         20.943
   1271       2         596.40          51[illegible].70
 WG = 0.480000E+05  WFA = 0.503730E+04  WFR = 0.503725E+04
 WG = 0.490000E+05  WFA = 0.458196E+04  WFR = 0.492634E+04
 WG = 0.494926E+05  WFA = 0.493383E+04  WFR = 0.498360E+04
```

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-91

SINGLE ROTOR AUXILIARY PROPULSION HELICOPTER

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 40871. LB

FUSELAGE

LF	LENGTH(BODY+TAILBOOM)	50.1 FT.
LC	LENGTH(CABIN)	23.5 FT.
LB	LENGTH(BODY)	42.8 FT.
LTB	LENGTH(TAILBOOM)	7.3 FT.
XM	FWD. ROTOR LOCATION	20.7 FT.
WF	WIDTH	8.3 FT.
SF	WETTED AREA	1 60.2 SQ. FT.

WING - NO WING USED

HOR. TAIL

ARHT	ASPECT RATIO	4.179
SHT	AREA	104.5 SQ. FT.
BHT	SPAN	20.9 FT.
CBARHT	MEAN CHORD	5.[illegible] FT.
LAMBDA H	TAPER RATIO	0.555
(T/C)HT	THICKNESS/CHORD	0.15[illegible]
LTH	HOR. TAIL ARM	23.2 FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.500
SVT	AREA	57.3 SQ. FT.
BVT	SPAN	9.3 FT.
CBARVT	MEAN CHORD	6.2 FT.
LAMBDA VT	TAPER RATIO	0.500
ZTR	TAIL ROTOR(VERT.) LOCATION	[illegible] FT.
ZETAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	0.
(T/C)VT	THICKNESS/CHORD	0.150

MAIN ROTOR PYLON

AP	ASPECT RATIO	0.193
SFP	WETTED AREA	93.6 SQ. FT.
FAFP	FRONTAL AREA	4.4 SQ. FT.
HP1	HEIGHT	2.0 FT.
CBARFP	MEAN CHORD	1[illegible].4 FT.
LAMBDA FP	TAPER RATIO	0.638
(T/C)R	ROOT THICKNESS/CHORD	0.212
(T/C)T	TIP THICKNESS/CHORD	0.216

PRIMARY ENGINE NACELLE

LN	LENGTH	0.0 FT.
DM	MEAN DIAMETER	0. FT.
SW	WETTED AREA(TOTAL FOR ALL ENGINES)	0.0 SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION)

DAR	DIAMETER	6.0 FT.
AF	ACTIVITY FACTOR PER BLADE	100.0
SIGAR	SOLIDITY	0.163
MRA	NO. OF PROPELLERS	2.
NO. BLADES	NO. OF BLADES/PROP	4.
VTIP	TIP SPEED	927. FT./SEC

MAIN ROTOR

DMR	DIAMETER	54.9 FT.
SIGMR	SOLIDITY	0.140
WG/A	DISC LOADING	15.0 LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.0
NR	NO. OF ROTORS	1.
NO. BLADES	NO. OF BLADES/ROTOR	8.
THETA	BLADE TWIST	-10.000 DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.1[illegible]
VTIP	TIP SPEED	710. FT./SEC.

- NO TAIL ROTOR USED

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM   8-91

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W E I G H T S   D A T A     IN LBS

        MLF           MANEUVER LOAD FACTOR                       3.000
        ULF           ULTIMATE LOAD FACTOR                       4.500

   PROPULSION GROUP
            WPRG      TOTAL MAIN ROTOR GROUP                      5318.
        K12 WPRB          MAIN ROTOR BLADE (PER ROTOR)                2289.
        K13 WPH           MAIN ROTOR HUB (PER ROTOR)                  2162.
            WBF           BLADE FOLDING(PER ROTOR)                     867.
        K15 WAR       AUXILIARY PROPULSION ROTOR GROUP             265.
            WDS       DRIVE SYSTEM                                2900.
        K16 WPDS          MAIN ROTOR DRIVE SYSTEM                     2900.
        K20 WTRDS         TAIL ROTOR DRIVE SYSTEM                        0.
        K17 WADS          AUXILIARY PROPULSION DRIVE SYSTEM              0.
        K18 WEP       PRIMARY ENGINES                             1196.
        K19 WEA       AUXILARY ENGINES                               0.
            WPEI      PRIMARY ENGINE INSTALLATION                  357.
            WAEI      AUXILIARY ENGINE INSTALLATION                  0.
            WFS       FUEL SYSTEM                                  754.
        DELTA WP      PROPULSION GROUP WEIGHT INCREMENT              0.
              WP   TOTAL PROPULSION GROUP WEIGHT                              1 785.

   STRUCTURES GROUP
        K8  WW        WING                                           0.
            WTG       TAIL GROUP                                   222.
        K9  WHT           HOR. TAIL                                    222.
        K14 WTR           TAIL ROTOR                                     0.
        K6  WB        FUSELAGE                                    3613.
        K7  WLG       LANDING GEAR                                1390.
            WNG           NOSE GEAR                                    278.
            WMG           MAIN GEAR                                   1112.
            WTES      TOTAL ENGINE SECTION                           0.
            WPES          PRIMARY ENGINE SECTION                         0.
            WAES          AUXILIARY ENGINE SECTION                       0.
        DELTA WST     STRUCTURE WEIGHT INCREMENT                   7[illegible].
              WST  TOTAL STRUCTURE WEIGHT                                     5716.

   FLIGHT CONTROLS GROUP
            WPFC      PRIMARY FLIGHT CONTROLS                     1668.
            WCC           COCKPIT CONTROLS                             119.
        K1  WRC           MAIN ROTOR CONTROLS                          529.
        K2  WSC           MAIN ROTOR SYSTEMS CONTROLS                  741.
        K3  WFW           FIXED WING CONTROLS                          294.
            WTM           TILT MECHANISM                                 0.
            WSAS          SAS                                           75.
            WAFC      AUXILIARY FLIGHT CONTROLS                   4872.
        K4  WRCA          AUX. PROPULSION ROTOR CONTROLS              4777.
        K5  WSCA          AUX. PROPULSION ROTOR SYS. CONTROLS          1[illegible]1.
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WMC	MISCELLANEOUS CONTROLS		0.	
DELTA WFC	CONTROL WEIGHT INCREMENT	0.		
WFC	TOTAL CONTROL WEIGHT			6540.
WFE	WEIGHT OF FIXED EQUIPMENT			5622.
WE	WEIGHT EMPTY			28663.
WFUL	FIXED USEFUL LOAD			1550.
OWE	OPERATING WEIGHT EMPTY			3 213.
WPL	PAYLOAD			5630.
(WF)A	FUEL			5028.
WG	GROSS WEIGHT			4 871.

SAMPLE CASE NO. 4 RUN 3 PAGE 4

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM R-91

R O T O R D A T A

FIXED MAIN ROTOR SOLIDITY INPUT

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SAMPLE CASE NO. 4   RUN 3                                                        PAGE  5

                                          H E S C O M P
                      HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    B-91


P R O P U L S I O N   D A T A
       PRIMARY PROPULSION CYCLE NO.     1.820
               TURBOSHAFT ENGINE

                4.  ENGINES
          BHP*P          MAX. STANDARD S.L. STATIC H.P.          8649.     H.P.

          ENGINE SIZED FOR TAKEOFF AT T/W =1.13
          100.0 PERCENT MILITARY POWER SETTING,
          H =     0. FT, TEMPERATURE = 89.80 DEG.F.,
           0.0   ENGINES INOPERATIVE, AND    0.0  FT/MIN VERTICAL RATE OF CLIMB.

          NO CRUISE CONDITION SPECIFIED.

       NO AUX. INDEPENDENT ENGINE CYCLE SELECTED

               MAIN ROTOR DRIVE SYSTEM RATING          6835.     H.P.

        XMSN SIZED AT  94. PERCENT OF MAIN ROTOR HOVER POWER REQUIRED
        AT H =     0. FT, TEMP = 89.80 DEG.F., 100.0 PERCENT HOVER RPM

               AUXILIARY PROPULSION DRIVE SYSTEM RATING          6835.     H.P.

        XMSN SIZED AT  94. PERCENT OF TOTAL CONFIGURATION POWER REQUIRED TO HOVER
        AT H=    0. FT, TEMP = 89.80  DEG.F., 100.0 PERCENT HOVER RPM
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SAMPLE CASE NO. 4   RUN 3                                                         PAGE  6

                                        H E S C O M P
                   HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM     H-91


A E R O D Y N A M I C S   D A T A
         FE               TOTAL EFFECTIVE FLATPLATE AREA           22.913      SQFT
         SWET             TOTAL WETTED AREA                        1437.       SQFT
         CPARF            MEAN SKIN FRICTION COEFF.              0.015947
      D R A G   B R E A K D O W N           IN  SQFT
         FEW              WING FE                                       0.
         FEF              FUSELAGE FE                                 22.913
         FEFP             FORWARD(MAIN) ROTOR PYLON FE                  0.0
         FEAP             AFT ROTOR PYLON FE                            0.0
         FEMRH            MAIN ROTOR HUB(S) FE                          0.0
         FETRH            TAIL ROTOR HUB FE                             0.0
         FEVT             VERTICAL TAIL FE                              0.0
         FEHT             HORIZONTAL TAIL FE                            0.0
         FEN              PRIMARY ENGINE NACELLE FE                     0.0
         FENI             AUX. INDEPENDENT CRUISE ENG. NAC. FE          0.0
         FENS             AUX. INDEPENDENT CRUISE ENG. STRUT FE         0.0
         DELTA FE         INCREMENTAL FE                                0.
A E R O D Y N A M I C   C O E F F .
         A5                                                         22.91299
         A6                                                          0.0
         A7                                                          0.0
         A8                                                          0.0
         A9                                                          0.24055
         E        WING LIFT EFFICIENCY FACTOR                 1.0
         EVT      VERTICAL TAIL LIFT EFFICIENCY FACTOR        0.88071
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H F S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM 8-91

MISSION PERFORMANCE DATA

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRESS. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	AUX. TURB. TEMP. (R)	AUX. ENG. CODE	AUX. ENG. PEHF	AUX. ENG. FUEL FLOW (LBS/HR)	TEMP. DEG. (F)
0.0	0.0	0.0	40871.	0.	0.0	1750.0	T	0.0	1004.	----	----	----		59.0
0.033	0.0	33.1	40837.	0.	0.0	1750.0	T	0.0	1004.	----	----	----		59.0

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 FOR 0.050 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	BHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	ROTLIM CODE		TEMP DEG. (F)	DELDCM	FMI	CPPRO	CPIND	CDO
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.033	0.0	33.1	40837.	0.	0.0	2639.3	T	1.000	3736.	1.129	0.729	7284.	0.0154	0.110
700.0	7065.	0.0	0.	0.	3736.		A		89.8	0.0	0.729	0.0	0.0	0.0
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.058	0.0	126.5	40744.	0.	0.0	2639.3	T	1.000	3736.	1.129	0.729	7263.	0.0154	0.110
700.0	7043.	0.0	0.	0.	3736.		A		89.8	0.0	0.729	0.0	0.0	0.0
INSUFFICIENT POWER AVAILABLE TO HOVER (T/W) AVAILABLE LESS THAN (T/W) REQUIRED AT DESIGN DOWNLOAD														
0.083	0.0	219.9	40651.	0.	0.0	2639.3	T	1.000	3736.	1.129	0.728	7237.	0.0153	0.110
700.0	7029.	0.0	0.	0.	3736.		A		89.8	0.0	0.728	0.0	0.0	0.0

CLIMB TO 4000. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	EHP	R/C (FPM)
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP	T.ROTOR RHP	PROP VTIP	PRIM.ENG FUEL FLOW	BHP AUX	ETAF PROF	TAUX/T	AUX. ENG. FUEL FLOW	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST	

(FPS)		(FPS)		(FPS)	(LBS/HR)				(LBS/HR)					
CPPRO	CPTIP	CPFAR	CPNUD	CDO	DELCDS	DELCDP	CXR	ROTLIM CODE	J	CP	CT	CLV	CCW	RK
0.083	0.0	219.9	40651.	0.	56.1	2645.0	T	1.[illegible]	53.4	.234	[illegible].099	-1.[illegible]	[illegible]1.2	7377. 38[illegible].
760.0	1746.	0.0	0.	----	2781.	3.	[illegible]	[illegible]	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.[illegible]0229	A	----	----	----	----	----	----
0.087	0.45	236.5	40634.	1[illegible].	57.1	2645.	T	1.[illegible]	[illegible].	.237	.1[illegible]2	-.[illegible]	[illegible]	7272. 37[illegible].
770.[illegible]	1766.	0.0	0.	----	3706.	3.	[illegible].8[illegible]	0.009	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	[illegible]	[illegible]	[illegible].[illegible]0233	A	----	----	----	----	----	----
0.092	[illegible].86	[illegible]	40613.	2[illegible].	58.1	2645.	T	1.0[illegible]	52.[illegible]	.23[illegible]	.1[illegible]	-.[illegible]	1[illegible]	7162. 36[illegible].
753.[illegible]	1788.	[illegible]	0.	----	3630.	3.	[illegible].8[illegible]	0.010	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	[illegible]	[illegible]	[illegible].[illegible]0234	A	----	----	----	----	----	----
0.096	1.39	265.7	40[illegible]1.	3[illegible].	69.1	2645.[illegible]	T	1.0[illegible]	52.1	.24[illegible]	.1[illegible]	-.[illegible]	1[illegible].2	7[illegible]47. 3542.
790.0	1811.	0.0	0.	----	3554.	3.	0.890	0.010	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.[illegible]0243	A	----	----	----	----	----	----
0.101	1.79	286.4	40[illegible]4.	4[illegible].	1[illegible].1	2645.	T	1.0[illegible]	51.6	.244	.112	-.[illegible]	1[illegible]	[illegible]27. [illegible]44[illegible].
750.[illegible]	[illegible].	0.0	0.	----	3477.	3.	[illegible].8[illegible]	0.01[illegible]	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00024[illegible]	A	----	----	----	----	----	----

CRUISE AT NORMAL ENGINE RATING

TIME (MES)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	OPTIM. TURB. TEMP. (R)	TRIM. ENG. CODE	TRIM. ENG. PCHF	EAS (KTS)	MU	CT TRIM OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (N.M/LB)	FM
N.ROTOR VTIP (FPS)	N.ROTOR SHP	T.ROTOR VTIP (FPS)	T.ROTOR SHP	PROP VTIP (FPS)	TOTAL FUEL FLOW (LBS/HR)	SHP AUX	STAB PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PCHF		AUX. ENG. THR. OR THRUST
CPPRO	CPTIP	CPFAR	CPNUD	CDO	DELCDS	DELCDP	CXR	ROTLIM CODE	J	CP	CT	CLV	CCW	RK
0.311	1.75	286.4	4[illegible]84.	4[illegible].	223.	[illegible]522.	T	[illegible].835	2[illegible].4.	.[illegible]	.1[illegible]	[illegible].1	.[illegible]	[illegible]4.
630.[illegible]	[illegible]72[illegible].	0.0	0.	----	[illegible]	[illegible]1.	.[illegible]	1.[illegible]12	----	----	----	----		----
0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.[illegible]	A	----	----	----	----	----	----
0.281	[illegible]1.74	[illegible]1.6	4[illegible].	4[illegible].	[illegible].7	[illegible]2.	T	.[illegible]	[illegible].7	.[illegible]	.15[illegible]	.1	.[illegible]1	[illegible]1.
625.0	[illegible].	[illegible]	[illegible]	----	[illegible]	[illegible]11.	.[illegible]	1.[illegible]12	----	----	----	----		----
0.0	[illegible]	[illegible]	0.0	[illegible]	[illegible]	[illegible]	-.[illegible]1[illegible]	A	----	----	----	----	----	----
0.4[illegible]	[illegible]1.75	1[illegible].1	36[illegible].	4[illegible].	[illegible]24.[illegible]	[illegible]	T	.[illegible]	[illegible].4	.[illegible]	.152	-[illegible]	.[illegible]	[illegible].
628.[illegible]	[illegible]7.	0.0	[illegible]	----	[illegible]	[illegible]	[illegible].[illegible]	1.612	----	----	----	----		----
0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	A	----	----	----	----	----	----
0.63[illegible]	1.1.79	19[illegible].7	38[illegible]4.	4[illegible].	[illegible].7	[illegible]	T	.[illegible]35	[illegible]	.[illegible]	.171	-.1	.74[illegible]	[illegible].
627.[illegible]	[illegible]11.	[illegible]	[illegible]	----	[illegible]	[illegible]	.[illegible]	1.[illegible]12	----	----	----	----		----
0.0	[illegible]	[illegible]	0.0	0.0	[illegible]	0.0	[illegible]	[illegible]	----	----	----	----	----	----

0.815	191.79	2456.6	38414.	41??.	225.9	2522.?	T	0.839	266.7	0.60?	0.13	-?.1	.7432	575?.
625.?	2816.	6.0	6.	----	3040.	2693.	0.8?0	1.012	----	----	----	----		----
3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10036	A	----	----	----	----	----	----
0.934	1??.69	2816.4	38?52.	41??.	226.4	2522.?	T	0.839	267.1	0.611	0.129	-?.2	.7447	575?.
625.?	282?.	0.0	0.	----	3?4?.	2888.	0.803	0.969	----	----	----	----		----
0.0	0.0	0.0	0.0	0.0	0.?	0.?	0.??049	A	----	----	----	----	----	----

DESCEND TO H = 0. FT. ,R = 200.03 N.MI. AT CONSTANT TAS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	HEP	R/S (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. EHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUD	CDP	DELCDS	DELCDP	CXR	POTLIM CODE	J	CP	CT	CLP	CDP	RN	
0.934	1??.69	2816.4	38?52.	4???.	17?.	?232.?	P	0.423	155.5	.41?	0.1?2	-2.7	-3.?	2946.	1???.
700.0	28??.	0.0	0.	----	1592.	0.	0.800	0.573	----	----	----	----		----	
3.0	0.3	0.0	0.0	0.0	0.?	0.0	0.??672	A	----	----	----	----	----	----	
0.951	191.51	2851.6	38?19.	3???.	17?.	2232.7	P	0.423	155.5	.41?	0.1?2	-2.7	-3.3	2943.	1??.
700.0	2855.	0.0	0.	----	1990.	0.	0.80?	0.574	----	----	----	----		----	
0.0	0.0	0.0	0.0	0.0	0.	0.0	0.??672	A	----	----	----	----	----	----	
0.968	194.34	2884.8	37986.	2???.	17?.	?232.4	P	0.422	155.5	0.410	0.102	-2.7	-3.3	2940.	10??.
700.0	2852.	0.0	0.	----	19??.	0.	0.8??	0.574	----	----	----	----		----	
0.0	0.0	0.0	0.	0.0	0.?	0.0	0.??671	A	----	----	----	----	----	----	
0.984	197.17	2918.0	37952.	1???.	176.	2232.?	P	0.422	155.5	.41	0.1?2	-2.7	-3.3	2937.	1???.
700.0	2849.	0.0	0.	----	19??.	0.	0.800	0.575	----	----	----	----		----	
3.0	0.0	0.0	0.0	0.0	0.	0.0	0.???67	A	----	----	----	----	----	----	
1.001	200.03	2951.1	37919.	0.	17?.	2231.7	P	0.421	155.5	.41	.1?2	-2.7	-3.3	2935.	1???.
700.0	2845.	0.0	0.	----	1987.	0.	0.800	0.575	----	----	----	----		----	
3.0	0.0	0.0	0.0	3.0	0.	0.0	0.???67?	A	----	----	----	----	----	----	

TAKEOFF, HOVER, OR LAND AT T/W = 1.03 FOR 0.200 HRS.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	THRUST TO WEIGHT	FM	EHP	CT	CT/SIGMA
M.ROTOR VTIP	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	VRC RHP	PRIM.ENG FUEL FLOW (LBS/HR)	AUX.ENG FUEL FLOW (LBS/HR)	POTLIM CODE		TEMP DEC. (F)	DELDCM	FMI	CPPAD	CTIND	CDP
1.001	200.0?	2951.1	37919.	0.	0.0	2377.4	P	0.6?7	513?.	1.?3	.7??	5?7?.	.?127	.??

700.0	5505.	0.0	0.	0.	3139.	----	A		59.0	0.0	0.708	0.0	0.0	0.0
1.181	290.85	3265.0	37636.	0.	0.0	2373.7	P	0.650	3116.	1.30	0.797	5611.	0.0122	0.087
700.0	5443.	0.0	0.	0.	3116.	----	A		59.0	0.0	0.707	0.0	0.0	0.0
1.201	266.08	3576.6	37294.	0.	0.0	2360.1	P	0.643	3093.	1.30	0.707	5549.	0.0121	0.087
700.0	5382.	0.0	0.	0.	3093.	----	A		59.0	0.0	0.707	0.0	0.0	0.0

CHANGE PAYLOAD, REMOVE 2300. LB.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.201	200.00	3576.6	37294.	0.
1.211	200.00	3576.6	35294.	0.

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.211	200.00	3576.6	35294.	0.
1.211	200.00	3576.6	35294.	1000.

LOTTER FOR 0.750 HRS. FOR RESERVE FUEL

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PERF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA T/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	BHP
M.ROTOR VTIP (FPS)	M.ROTOR BHP	T.ROTOR VTIP (FPS)	T.ROTOR BHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PERF		AUX. ENG. BHP OR THRUST
CPPPD	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDW	CXR	ROTLIM CODE	J	CP	CT	CL	CDW	RN
1.211	200.00	3576.6	35294.	1000.	71.7	1956.1	P	0.171	70.7	0.173	0.085	-0.6	1586.	1494.
700.0	1405.	0.0	0.	----	1586.	2.	0.800	0.019	----	----	----	----	----	----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000123	A	----	----	----	----		----
1.461	200.00	3973.1	34897.	1000.	70.7	1953.1	P	0.168	69.7	0.17	0.084	-0.6	1578.	1431.
700.0	1386.	0.0	0.	----	1578.	2.	0.800	0.020	----	----	----	----	----	----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000120	A	----	----	----	----		----
1.711	200.00	4367.5	34503.	1000.	70.7	1950.0	P	0.165	69.7	0.173	0.083	-0.6	1570.	1406.
700.0	1361.	0.0	0.	----	1570.	2.	0.800	0.020	----	----	----	----	----	----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000120	A	----	----	----	----		----
1.961	200.00	4759.0	34111.	1000.	70.7	1946.8	P	0.162	69.7	0.17	0.082	-0.6	1562.	1381.
700.0	1338.	0.6	0.	----	1562.	2.	0.800	0.019	----	----	----	----	----	----
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000120	A	----	----	----	----		----

```
MISSION FUEL REQUIRED =  3576.55
RESERVE FUEL REQUIRED =  1450.87
TOTAL   FUEL REQUIRED =  5027.42

*****************************************************************************************

END  OF  SUCCESSFUL  CASE

*****************************************************************************************
```

7.3.5 Single Rotor Winged Helicopter

The design mission profile is illustrated in Figure 7-5. The engine and rotor cycles are not discussed in this case. A complete copy of the program printout follows the description of the input.

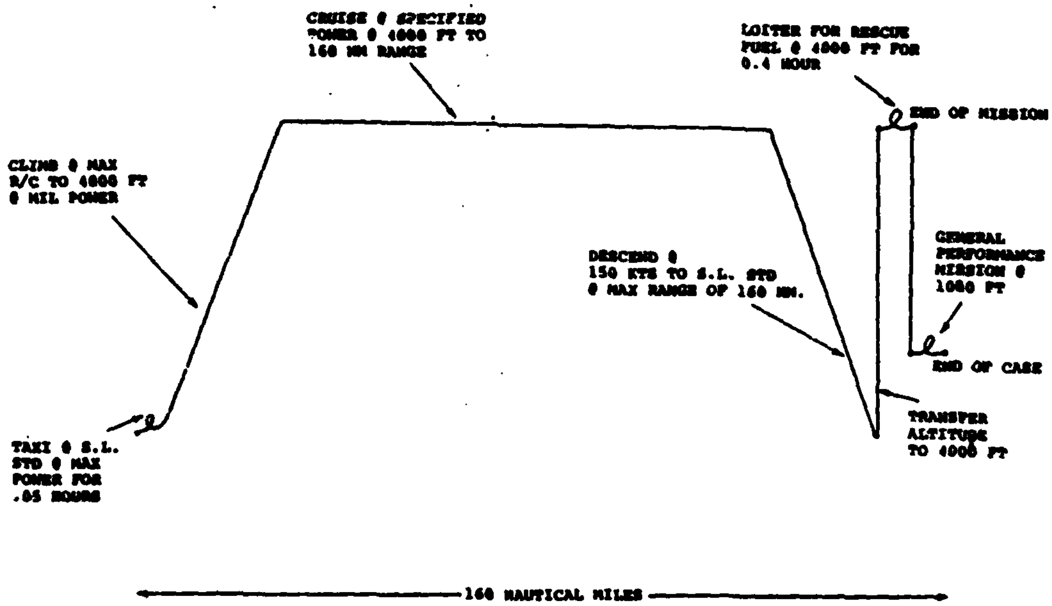

Figure 7-5. Design Mission - Sample Case No. 5

SAMPLE CASE NO. 5

GENERAL INFORMATION SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
OPTIND	0001	1.	Sizing run
OPTIONAL PRINT	0002	1.	Detailed printout desired
DRGIND	0003	2.	GW/Fe drag trend utilized
OSWIND	0004	0	User inputs Oswald's efficiency factor (e)
CNFIND	0005	1.	Single rotor helicopter desired
AUXIND	0006	2.	Configuration includes wings only
RDMIND	0007	3.	User inputs the diameter, location 0182, C_T/σ
FIXIND	0008	1.	Program sizes primary engines
ROTIND	0009	1.	Performance calculated by short method
SWIND	0010	3.	Size for maneuver
BWIND	0011	2.	User inputs wing aspect ratio
ENGIND	0013	.0	Turboshaft (power producing) cycle
TRDIND	0015	1.	Use trend of diameter main/diameter tail = fn (W/A) MAIN
TRSIND	0016	2.	Input C_T/σ
VTFIND	0017	1.	Input locations 0135 + 0138 AR_{VT} and ζVT respectively

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
HTIND	0018	2.	Horizontal tail volume coefficient input
MRPIND	0019	0.	Main rotor position on fuselage input by user
ESCIND	0022	1.	Program will size engines for takeoff only
WG_o	0023	9000.	First guess at design gross weight
h_o	0024	.0	Initial altitude } Normally 0.0 except for mission analysis
R_o	0025	.0	Initial range
t_o	0026	.0	Starting time
$h_{OPT_{IND}}$	0027	.0	Cruise at specified altitude
M_{Mo}	0028	.333	Maximum operating Mach number
V_{Mo}	0029	220.	Maximum operating equivalent airspeed knots
V_{DIVE}	0030	240.	Dive speed - approximately equal to 1.2 x V_Mo in knots
M_{LF}	0031	3.	Maneuver load factor
K_1	0032	1.	Factor on mission fuel burned to give reserve fuel. 1.111 results in 10% of initial fuel for reserve
δW_f	0033	.0	Fixed fuel increment for reserves or other use
K_{FF}	0034	1.05	Increase basic engine SFC by 5 percent

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
SGTIND	0035	1.0	Taxi	Sequence of design mission
	0036	3.	Climb	
	0037	4.	Cruise	
	0038	5.	Descent	
	0039	9.	Transfer altitude	
	0040	60.0	Loiter for reserve fuel	
	0041	0.0	End of mission	
	0042	11.	General performance	
	0043	100.0	End of case	

HELICOPTER DIMENSIONAL INFORMATION SHEET

AR	0104	4.5	Wing aspect ratio
$(+/c)R$	0105	.17	Wing root thickness to chord ratio
$(+/c)T$	0106	.13	Wing tip thickness to chord ratio
$\Lambda_{c/4}$	0107	.0	Sweep angle of wing quarter chord (degrees)
λ	0108	.6	Taper ratio of wing
$C_{F/C}$	0109	.3	Ratio of download alleviating flap chord to wing chord
$h'/_{nf}$	0110	.5	Ratio of wing height on fuselage (relative to the bottom of the fuselage), h', to the total fuselage height, h_F
C_{LD}	0111	.313	Wing design lift coefficient

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
AR_{HT}	0112	4.	Horizontal tail aspect ratio
ℓ'_{TH}	0113	1.	Ratio of horizontal tail moment arm to main rotor radius
$(t/c)_{HT}$	0114	.15	Horizontal tail thickness/ chord ratio
$\bar{V}_H$	0115	.0149	Horizontal tail volume coefficient referred to main rotor diameter and tail arm
λ_H	0116	1.	Horizontal tail taper ratio
$\Delta S_{WET}/Sp$	0120	.1	Fuselage wetted area ratio
ΔS_{WT}	0121	.0	Incremental fuselage wetted area
h_F	0122	5.862	Fuselage height
W_F	0123	5.862	Fuselage width
$(\ell/d)_p$	0124	1.4357	Fineness ratio of nose
$(\ell/d)_T$	0125	.583	Fineness ratio of tail
ℓ_C	0126	6.833	Constant diameter section length
ℓ_{RW}	0127	.0	Length of ramp well
(X_M/ℓ_B)	0128	.6	Main rotor position aft of the nose as a fraction of main fuselage length
$(\ell_{TB}/d_{\overline{TB}})$	0129	3.33	Fineness ratio of tail boom
$(d_{\overline{TT}}/d_{\overline{TB}})$	0130	.3	Ratio of average tail boom tip diameter to average tail boom diameter

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
K_T STING	0131	-.558	Tail boom (on single rotor helicopter) length extending aft of tail rotor center as a fraction of tail rotor radius
AR_{UT}	0135	1.5	Vertical tail aspect ratio
λ_{VT}	0136	.7	Vertical tail taper ratio
$(t/c)_{VT}$	0137	.15	Thickness/chord ratio of vertical tail
ζ_{VT}	0138	1.	Vertical tail span overlap distance/tail rotor radius ratio - input as a function of tail rotor radius
K_z	0139	1.	Vertical position of the tail rotor center (relative to the vertical fin root chord) as a fraction of tail rotor radius. When TRDIND=0, (as in this example), vertical tail span is input into this location.
Z_1	0142	.0	Primary engine nacelle dimensional factors
Z_2	0143	.0	
Z_3	0144	.0	
ℓ_{AIP}/ℓ_c	0145	.0	Ratio of air induction system length to primary engine length
$(t/c)_{RF}$	0152	.45	Main rotor pylon root thickness/chord ratio
$(t/c)_{TF}$	0153	.25	Main rotor pylon tip thickness/chord ratio
AR_{FP}	0154	.21	Main rotor pylon aspect ratio

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
λ_{FP}	0155	.74	Forward rotor pylon taper ratio
$h_p l$	0156	.75	Main rotor pylon height

ROTOR DIMENSIONAL DATA FOR SIZING MAIN ROTOR

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ROTOR CYCLE NO.	0171	6.5	Rotor cycle number
N_R	0172	1.	Number of rotors
W/A	0173	8.	Main rotor disc loading
D_{MR}	0174	38.	Main rotor diameter
b_{MR}	0176	4.	Number of main rotor blades
θ_{TMR}	0177	-12.	Main rotor twist (degrees)
Xc_{MR}	0178	.2	Main rotor blade cutout as a fraction of radius
X_{MR}	0179	.07	Main rotor blade attachment point as a fraction of radius
$(t/c)_{.25R}$	0180	.12	Rotor blade thickness/chord at 25 percent radius
V_T	0181	766.7	Main rotor tip speed
$(C_T/\sigma)_H$	0182	.14	Ratio of thrust coefficient to rotor solidity (helicopter C_T=Thrust/(PAV_{TIP}^2), includes (C_T/σ), (C_T/σ)Des(H), (C_T/σ)CR
$T/_W$	0183	1.03	Configuration thrust/weight ratio (hover)

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$V_{KT}(c)$	0184	180.	Velocity in knots for cruise condition for rotor and wing sizing
$h_c(c)$	0185	2000.	Cruise altitude for sizing main rotor solidity
ΔTINC	0186	18.1	Temperature increment for cruise condition for rotor and wing sizing
$(C_T/\sigma)_{CR}$	0187	.07518	Ratio of thrust coefficient to rotor solidity (helicopter C_T = Thrust/ $PAV_{TIP}2$), includes (C_T/σ), (C_T/σ)Des(H), (C_T/σ)CR
gREQM'T	0188	1.	Total maneuver g requirement helicopter must satisfy (wing + rotor)-g
g(ROTOR)	0189	.7	Maneuver g's which rotor must carry. In the case of a pure helicopter, gRQMT = g_{ROT}
N(ROTOR LOADING)	0190	.7	Rotor loading (rotor lift/$_{GW}$)
V_{CEH1}	0191	1.53	Main rotor vertical rate of climb efficiency factors
V_{CEH2}	0192	.0	
K_{pCLIMB}	0193	.85	Helicopter forward flight climb efficiency
$K_{pDESCENT}$	0194	.85	Helicopter forward flight descent efficiency
bTR	0203	4.	Blade number per tail rotor or propeller

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$\theta_{T_{TR}}$	0204	-9.	Tail rotor blade twist
X_{CTR}	0205	.05	Tail rotor blade cutout (end of blade shank, beginning of rotor air-foil sections) position as a fraction of rotor radius
X_{TR}	0206	.02	Tail rotor blade attachment point as a fraction of rotor radius
$V_{TTR_{REF}}$	0207	766.7	Tail rotor design tip speed (hover) - (fps)
(C_T/σ) DES(M)	0208	.14	Ratio of thrust coefficient to rotor solidity (helicopter C_T = Thrust/ $PAV_{TIP}{}^2$)
YAW ACCEL $(\ddot{\Psi})$	0209	1.	Helicopter yaw acceleration, rad/sec^2
YAW RATE $(\dot{\Psi})$	0210	0.	Helicopter yaw rate, rad/sec^2
CT_G/CT_{NET}	0211	1.07	Ratio of tail rotor total thrust coefficient to net thrust coefficient, where $C_{TNET} = C_{TG\text{-}Fin}$ blocking losses
K_{ZZZ}	0213	1.	Single rotor helicopter yaw moment of inertia adjustment factor

ROTOR DIMENSIONAL DATA FOR SIZING TAIL ROTOR

$g_{MR/TR}$	0214	.5	Gap between main and tail rotor disc (FT). When TRDIND=0, represents gap between main rotor disc and end of tail boom (FT). Negative number implies tail boom ends under the main rotor disc.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
K_{TRS}	0215	1.	Tail rotor solidity multiplicative factor (used to determine tail rotor solidity)
$C_{L_{FIN}}$	0216	.2	Vertical tail fin operating cruise lift coefficient

PRIMARY ENGINE SIZING INFORMATION SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Primary Engine Cycle No.	0217	3.11	Primary engine selection
N_p	0219	1.	Number of primary engines
SHP_{MRX}/SHP^*_{MR}	0221	.7625	Main rotor drive system is rated at 102% of main rotor design power
η_T	0223	.0	Transmission efficiency
ΔSHP_{ACC}	0224	.97	Accessory power losses
SHP_{TRX}/TRP^*	0225	.1	Ratio of tail rotor drive system XMSN rating to tail rotor design power
$H_{TO(H)}$	0227	4000.	Design power hover altitude for engine sizing
$(T/W)_D$	0228	1.03	Configuration design point hover thrust/weight ratio
$\Delta T_{IN\ TO}(H)$	0229	50.3	Temperature increment in degrees above standard at altitude for engine sizing
$(N_{II}/N_{II_{MAX}})_{T.O.}$	0230	1.	Operating point for engine power turbine. Operating tip speed is computed from

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
			$V_{T_{OPERATING}} = V_T \left[\frac{N_{II}}{N_{IIMAX}}\right]\left[\frac{N_{II_{MAX}}}{N_{II}^*}\right]$ To operate at V_T = 625 ft/sec requires that $N_{II}/N_{II_{MAX}}$ be the recripocal of $\frac{N_{II_{MAX}}}{N_{II^*}}$
N_{PSD}	0231	.0	Number of engines inoperative at hover design point conditions
$SHP_E/SHP*$	0232	.95	Engines sized to permit operation at 100% of maximum rated power
$(V_{R/C})_D$	0233	450.	500 ft/min vertical rate of climb capability required at hover design point.
POWIND	0234	2.0	Maximum engine rating for cruise engine sizing. For this example, normal rated power is the maximum rating to be used.
h_c	0235	2000.	Design point cruise altitude for engine sizing.
V_c	0236	180.	Design point cruise speed for engine sizing.
$\Delta T_{IN_{CE}}$	0237	18.1	Temperature increment above standard for cruise engine sizing.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$(N_{II}/N_{II_{MAX}})_C$	0238	1.	
$C_{L_{D_P}}$	0240	.4873	Wing operating lift coefficient at cruise condition for engine sizing
$(N_{PSD})_C$	0241	.0	No. of primary engines shut down during cruise (for engine sizing)

HELICOPTER AERODYNAMICS INFORMATION SHEET

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
GW/Fe	0312	1097.6	Drag trend constants are derived from data such as illustrated by Figure 4-30, Section 4.9
K_{FED}	0313	.51108	
TFEF	0315	1.	Tail fin aspect ratio effectiveness factor
K_N	0327	1.	Wing multiplicative drag factor
(Re/ℓ)i	0328	.195 E+07	Mean Reynolds number per foot of mission
Cℓa	0329	6.28	Two-dimensional wing lift coefficient slope (Rad^{-1})
NO. OF PAIRS IN $C_L+C_{D_{wi}}$ TABLE	0330	2.	
CLW	0331 0332	.0 10.	Wing lift coefficient
C_{DWi}	0339 0340	.009 .009	Profile drag coefficient of wing at Fe = 10 (based on wing planform area)
No. of C_X/σ	0347	3.	Specifies number of C_X/σ values in table locations 0349-0353.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
No. of μ	0348	3.	Specifies number of μ values in table locations 0354-0360.
VALUES OF C_X/σ	0349	-1.	Rotor propulsive thrust coefficient divided by main rotor solidity. Used in defining rotor limits
	0350	0.	
	0351	-1.	$C_X/_\sigma = \dfrac{\text{THRUST REQUIRED}}{\dfrac{\pi D_{MR}{}^2 N_R V_{TIP}{}^2 \sigma_{MR}}{4}}$
VALUES OF μ	0354	.0	Rotor forward flight advance ratio
	0355	.5	
	0356	1.	$\mu = \dfrac{V_{FPS}}{V_{TIP}}$
VALUES OF C_T'/σ	0361	1.	Values of C_T'/σ corresponding to $(C_X/\sigma)_1$, location 0349 and μ_1, μ_2, and μ_3
	0362	1.	
	0363	1.	
	0368	1.	Value of C_T'/σ corresponding to $(C_X/\sigma)_2$ location 0350 and μ_1, μ_2, and μ_3
	0369	1.	
	0370	1.	
	0375	1.	Values of C_T'/σ corresponding to $(C_X/\sigma)_3$ location 0351 and μ_1, μ_2, and μ_3
	0376	1.	
	0377	1.	

HELICOPTER WEIGHT INFORMATION SHEET

W_{FE}	2602	1784.	Weight of fixed equipment in Lbs.
W_{FUL}	2603	1250.	Weight of fixed useful load in Lbs.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
W_{PL}	2604	530.	Weight of payload in Lbs.
ΔW_{FL}	2605	50.	Flight controls group incremental weights in Lbs.
ΔW_{P}	2606	100.	Propulsion group incremental weight in Lbs.
ΔN_{ST}	2607	.0	Structures group incremental in Lbs.
RM_{1}	2608	.0	Wing relief as percentage of GW.
W_{i}	2609	.0	Weight of inboard store.
W_{o}	2610	.0	Weight of outboard store
d_{i}	2611	.0	Position of inboard underwing store (fraction of wing semi-span).
d_{o}	2612	.0	Position of outboard underwing store (fraction of wing semi-span)
k_{u}	2613	26.	Cockpit controls weight factor
k_{RL}	2614	20.	Main rotor controls weight factor
k_{SL}	2615	30.	Main rotor system controls weight factor
k_{FW}	2616	.0	Fixed wing controls
k_{TM}	2617	.015	Tilt mechanism weight factor
k_{SAS}	2618	75.	Stability Augmentation System (SAS) weight factor. Usually in the range of 20-100 pounds.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{RCA}	2619	.0	Auxiliary rotor controls weight factor.
k_{SCA}	2620	.0	Auxiliary rotor system controls weight factor.
k_{KMC}	2621	.0	Miscellaneous controls weight factor in Lbs.
k_B	2622	125.	Body group weight factor.
ΔC.G.	2623	.8	Helicpter c.g. travel (ft).
k_{LG}	2624	.03	Landing gear weight factor. Percentage of gross weight.
k_{MG}	2625	.8	Main landing gear weight factor.
K_{WW}	2626	.8	Detailed wing weight factor. This adjusts the constant 220 in $W_W = 220(k)^{0.585}$ up or down depending on the complexity of the control surfaces.
CF	2627	1.	Wing unload factor. Entered as a fraction of design gross weight.
k_{WS}	2628	.0	Wing stores only weight trend factor.
k_{ap}	2629	4.	Wing weight/area factor(psf)
k_{HT}	2630	1.5	Horizontal tail unit weight in PSF.
k_{CLF}	2631	.0	Crash load factor.
k_{NAC}	2632	.0	Primary cowling weight factor (PSF)
k_{AIP}	2633	125.	Primary air induction system weight factor.
k_{NACA}	2634	.0	Auxiliary cowling weight factor (PSF)

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{AIA}	2635	.0	Auxiliary air induction system weight factor.
k_{NS}	2636	.0	Nacelle strut weight factor.
k_{PRB}	2637	44.	Primary rotor blade weight factor.
k_{RBF}	2638	2.2	Rotor type factor; hingeless for this example.
k_{PH}	2639	61.	Primary hub weight factor.
k_{amd}	2640	.54	Main rotor weight factor.
k_{BLFD}	2641	1.	Blade fold weight factor. Input as a fractional part of the total rotor weight.
k_{TR}	2642	13.	Tail rotor weight factor.
k_{AR}	2643	.0	Auxiliary rotor weight factor. This is the average value for the rotor or propeller weight (LB). $W_R = 14.2\ a(k)^{.67}$
k_{PA}	2644	1.	Auxiliary rotor multiplicative input power, expressed here as 100% input power.
k_{VTAR}	2645	1.	Auxiliary tail rotor multiplicative tip speed factor, expressed here as 100% input speed.
k_{PDS}	2646	230.	Primary drive system weight factor.
k_{PDSZ}	2647	3.	Primary drive system weight factor. Number of gears on system.
k_{TRDS}	2648	275.	Tail rotor drive system weight factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
k_{ADS}	2649	.0	Auxiliary drive system weight factor.
k_{ADSZ}	2650	.0	Auxiliary drive system weight factor (number of gears in system).
k_{FS}	2651	.15	Fuel system weight factor.
k_{PEI}	2652	.0	Primary engine installation weight factor.
k_{AEI}	2653	.0	Auxiliary engine installation weight factor.
K_1	2654	1.	Main rotor controls weight factor.
K_2	2655	.9	Main rotor system controls weight multiplicative factor.
K_3	2656	1.	Fixed wing controls weight multiplicative factor.
K_4	2657	1.	Auxiliary rotor controls weight multiplicative factor.
K_5	2658	1.	Auxiliary rotor system controls weight multiplicative factor.
K_6	2659	.85	Body weight multiplicative factor.
K_7	2660	.85	Landing gear weight multiplicative factor.
K_8	2661	1.	Wing weight multiplicative factor.
K_9	2662	1.	Horizontal tail weight multiplicative factor.
K_{10}	2663	1.	Primary nacelle weight multiplicative factor.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
K_{11}	2664	1.	Auxiliary nacelle weight nultiplicative factor.
K_{12}	2665	.9	Primary rotor blade weight multiplicative factor.
K_{13}	2666	.8	Primary rotor hub weight multiplicative factor.
K_{14}	2667	1.	Tail rotor weight multiplicative factor.
K_{15}	2668	1.	Auxiliary rotor weight multiplicative factor.
K_{16}	2669	.9	Primary drive system weight multiplicative factor.
K_{17}	2670	1.	Auxiliary drive system weight multiplicative factor.
K_{18}	2671	1.2	Primary engine weight multiplicative factor.
K_{19}	2672	1.	Auxiliary engine weight multiplicative factor.
K_{20}	2673	1.	Tail rotor drive system weight multiplicative. factor
AT MIND	0401	.0	Standard atmosphere selected.
$t_{T(NR)}$	0411	.05	Time in hours to taxi.
$(N_{II}/N_{II\ MAX})$	0441	1.	
CLMIND	0571	1.	Maximum rate of climb desired.
ATMIND	0591	0.	Standard atmosphere selected.
C_L WING	0601	.4873	Wing lift coefficient.
Δh (FT)	0621	1000.0	Altitude increments for climb calculations.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
POWIND	0631	1.	Climb at maximum rate of climb, limited by military power available.
h_{max} (ft)	0641	4000.	Final altitudes for climb.
$(N_{II}/N_{II_{MAX}})$	0651	1.	Operating point for engine turbine during climb.
$\Delta fe_{CL(ft^2)}$	0661	.0	Incremental drag area in climb.
$N_{PSD_{CL}}$	0681	.0	Number of primary engines shut down in climb.
CRSIND	0721	1.	Cruise at specified power.
ATMIND	0741	.0	Standard atmosphere selected.
CL_{WING}	0751	.4873	Wing lift coefficient.
ΔR(N.M.)	0771	40.	Calculation increments during cruise in nautical miles.
POWIND	0781	2.	Cruise speed by normal rated primary engine power.
$R_{MAX(N.M.)}$	0791	160.	Value of range at end of each cruise segment.
$(N_{II}/N_{II_{MAX}})$ (PRIM ENG)	0801	1.	
Δfe_{CR} (FT^2)	0811	.0	Increment in cruise equivalent flat plate area.
$N_{PSD\ CR}$	08311	.0	Number of primary engines shut down in cruise.
$N_{PSD\ i\ CR}$	0851	.0	Number of auxiliary independent engines shut down during cruise.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
DESIND	0871	1.	Descend at constant TAS.
TAS	0881	150.	True airspeed in knots.
R_{MAXIND}	0891	.0	Descent flight path ends at specified terminal range (cruise segment must be input previous to descent.
C_{LW}	0901	.4873	Wing lift coefficient.
ATMIND	0911	.0	Standard atmosphere selected.
Δh (FT)	0921	1000.	Step size for descent.
b_{MIN} (FT)	0941	.0	Minimum altitude during descent.
R/D (FPM)	0951	1000.	Rate of descent.
R_{MAX} (N.M.)	0961	160.	Range at end of descent.
$N_{II}/N_{II_{MAX}}$ (PRIM ENG)	0971	1.	
Fe_{DSC} (FT^2)	0981	.0	Increment in equivalent flat plate area parasite drag (descent performance segment)
$N_{PSD\ DSC}$	1001	.0	Number of primary engines shut down during descent.
ATMIND	1031	.0	Standard stmosphere selected.
C_{LW}	1041	.4873	Wing lift coefficient.
$\Delta t_{L(HR)}$	1061	.1	Step size for loiter.
$N_{II}/N_{II_{MAX}}$ (PRIM ENG)	1071	1.	
$t_{L(HR)}$	1081	.4	Incremental time for loiter.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$N_{PSD\ LOITER}$	1101	.0	Number of primary engines shut down during loiter.
$\Delta Fe_{L}(FT^2)$	1131	.0	Increment in equivalent flat plate area parasite drag (loiter performance segment).
h_{FINAL}(FT)	1181	4000.	Transfer altitude to these final values with no time, fuel or distance credits.

GENERAL PERFORMANCE INFORMATION STGIND = 11

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
GWIND	4140	1.	User inputs difference in gross weight, in location 4150.
ΔGW (LB)	4150	.0	Change in gross weight.
ATMIND	4160	.0	Standard atmosphere selecte
C_{LWING}	4170	.313	Wing lift coefficient
ΔFe_{CR} (FT^2)	4190	.0	Increment in equivalent flat plate area parasite (cruise performance segment).
ALTITUDE (FT)	4200	1000.	Altitude for general performance segment.
T/W	4210	1.03	Configuration thrust/ weight ratio (general performance segment).
$N_{II}/N_{II_{MAX}}$ (PRIM ENG)	4220	1.	
ΔV(KTS)	4230	20.	Calculation and printout velocity increments in knots during general performance information in location 4250.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
V_{MAX} (KTS)	4250	220.	Maximum calculation and printout velocity in knots during general performance information.
ENGINE CYCLE DATA; NON-STANDARD PERFORMANCE			
WDTIND	1201	1.	Fuel flow cutoff, refer location 1220.
N1IND	1202	1.	N1 cutoff, refer location 1221.
N1θIND	1203	.0	No referred N1 cutoff.
N2IND	1204	2.	Free turbine engine to be simulated.
QIND	1205	1.	Torque cutoff, refer location 1224.
RNOIND	1206	.0	No Reynolds No. corrections.
$\dot{W}_{MAX}/\dot{W}^*$	1220	1.205	Fuel flow limit - ratio of maximum fuel flow to fuel flow at maximum static power, sea level, standard atmosphere.
$N_{I_{MAX}}/N_I^*$	1221	1.017	Gas generator RPM limit - ratio of max gas generator RPM to RPM at maximum static power, sea level, standard atmosphere.
$N_{II_{MAX}}/N_{II}^*$	1223	.913	Value for referred NI limit
Q_{MAX}/Q^*	1224	1.	Value of torque cutoff referred to value at sea level standard static condition.

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-91

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+0001
VAL2 VALUE CORRESPONDING TO LOC.+0002
ETC.

NOTE : IN USING AUXILIARY ENGINES & AUXILIARY ENGINE CYCLE INPUT LOCATIONS CAN BE CREATED BY PLACING A 66666 CARD IN FRONT AND BEHIND A STANDARD ENGINE CYCLE

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
1201	5	1.0000	1.0000	.0	2.0000	1.0000
1206	1	.0				
1220	2	1.2050	1.0170			
1223	2	.91300	1.0000			
1301	3	3.1100	.28650	52.000		
1305	2	1400.0	1400.0			
1307	3	2495.0	2660.0	2660.0		
1310	1	8.0000				
1311	5	1300.0	1700.0	2000.0	2400.0	2600.0
1316	3	2900.0	3200.0	3500.0		
1319	1	3.0000				
1320	3	.0	.30000	.60000		
1326	3	.0	.0	.0		
1332	3	.12800	.12800	.12800		
1338	3	.31800	.31800	.31800		
1344	3	.59100	.59100	.59100		
1350	3	.92900	.92900	.92900		
1356	3	1.2110	1.2110	1.2110		
1362	3	1.4090	1.4090	1.4090		
1368	3	1.5890	1.5890	1.5890		
1374	1	8.0000				
1375	5	1300.0	1700.0	2000.0	2300.0	2600.0
1380	3	2900.0	3200.0	3500.0		
1383	1	3.0000				
1384	3	.0	.30000	.60000		
1390	3	.51000E-01	.51000E-01	.51000E-01		
1396	3	.12900	.12900	.12900		
1402	3	.21400	.21400	.21400		
1408	3	.33400	.33400	.33400		
1414	3	.47700	.47700	.47700		
1420	3	.59900	.59900	.59900		
1426	3	.69200	.69200	.69200		
1432	3	.77800	.77600	.77800		
1438	1	8.0000				
1439	5	1300.0	1700.0	2000.0	2300.0	2600.0
1444	3	2900.0	3200.0	3500.0		
1447	1	3.0000				
1448	3	.0	.30000	.60000		

1454	3	.62500	.62500	.62500		
1460	3	.75500	.75500	.75500		
1466	3	.84500	.84500	.84500		
1472	3	.92200	.92200	.92200		
1478	3	.98600	.98600	.98630		
1484	3	1.0410	1.0410	1.0410		
1490	3	1.1000	1.1000	1.1000		
1496	3	1.1660	1.1660	1.1660		
1502	1	8.0000				
1503	3	1300.0	1700.0	2000.0		
1506	5	2300.0	2600.0	2900.0	3200.0	3500.0
1511	1	3.0000				
1512	3	.0	.30000	.60000		
1518	3	.37800	.37800	.37800		
1524	3	.58900	.58900	.58900		
1530	3	.73900	.73900	.73900		
1536	3	.87000	.87000	.87000		
1542	3	.98100	.98100	.98100		
1548	3	1.0680	1.0680	1.0680		
1554	3	1.1420	1.1420	1.1420		
1560	3	1.2090	1.2090	1.2090		
1601	2	6.5000	-9.0000			
1603	3	.11420E-01	-.28300E-01	.26200		
1606	3	.27600	2.4500	.86500		
1609	2	.10420E-01	2.8200			
1611	5	.90000E-01	1.1700	.12400E-02	.75800	.78300
1616	1	10.000				
1617	5	.0	.40000E-02	.70000E-02	.90000E-02	.10000E-01
1622	5	.11000E-01	.11500E-01	.12000E-01	.15500E-01	.22000E-01
1627	5	1.0160	1.0850	1.1540	1.2330	1.2790
1632	5	1.3140	1.3270	1.3370	1.3640	1.3970
1637	1	1.0000				
1	5	1.0000	1.0000	2.0000	.0	1.0000
6	5	2.0000	3.0000	1.0000	1.0000	3.0000
11	1	2.0000				
13	1	.0				
15	5	1.0000	2.0000	1.0000	2.0000	.0
22	4	1.0000	9000.0	.0	.0	
26	5	.0	.0	.33300	220.00	240.00
31	5	3.0000	1.0000	.0	1.0500	1.0000
36	5	3.0000	4.0000	5.0000	9.0000	60.000
41	3	.0	11.000	100.00		
104	2	4.5000	.17000			
106	5	.13000	.0	.60000	.30000	.50000
111	5	.31300	4.0000	1.0000	.15000	.14900E-01
116	1	1.0000				
120	1	.10000				
121	5	.0	5.0620	5.0620	1.4357	.58300
126	5	6.0330	.0	.60000	3.3330	.30000
131	1	-.55800				
136	5	1.5000	.70000	.15000	1.0000	1.0000
142	4	.0	.0	.0	.0	
152	5	.45000	.25000	.21000	.74000	.75000
171	4	6.5000	1.0000	8.0000	38.000	
176	5	4.0000	-12.000	.20000	.70000E-01	.12000
181	5	766.70	.14000	1.0300	180.00	2000.0
186	5	18.100	.75100E-01	1.0000	.70000	.70000
191	2	1.5300	.0			
193	2	.85000	.85000			
203	3	4.0000	-9.0000	.50000E-01		

206	5	.20000E-01	766.70	.14000	1.0000	.0
211	1	1.0700				
213	3	1.0000	.50000	1.0000		
216	1	.20000				
217	1	3.1100				
219	1	1.0000				
221	5	.76250	.0	.97000	20.000	.10000
227	4	4000.0	1.0300	50.300	1.0000	
231	5	.0	.95000	450.00	2.0000	2000.0
236	3	100.00	10.100	1.0000		
240	2	.48730	.0			
312	4	1097.6	.51100	.70000	1.0000	
330	1	2.0000				
327	1	1.0000				
331	2	.0	10.000			
328	1	.19500E+07				
329	1	6.2800				
331	2	.0	10.000			
339	2	.90000E-02	.90000E-02			
347	5	3.0000	3.0000	-1.0000	.0	1.0000
354	3	.0	.50000	1.0000		
361	3	1.0000	1.0000	1.0000		
368	3	1.0000	1.0000	1.0000		
375	3	1.0000	1.0000	1.0000		
2602	4	1784.3	1250.0	530.00	50.000	
2606	5	100.00	.0	.0	.0	.0
2611	5	.0	.0	26.000	20.000	30.000
2616	5	.0	.15000E-01	75.000	.0	.0
2621	5	.0	125.00	.80000	.30000E-01	.80000
2626	5	.0	1.0000	.0	4.0000	1.5000
2631	5	.0	.0	125.00	.0	.0
2636	5	.0	44.000	2.2000	61.000	.54000
2641	5	1.0000	13.000	.0	1.0000	1.0000
2646	5	230.00	3.0000	275.00	.0	.0
2651	5	.15000	.0	.0	1.0000	.90000
2656	5	1.0000	1.0000	1.0000	.85000	.85000
2661	5	1.0000	1.0000	1.0000	1.0000	.90000
2666	5	.80000	1.0000	1.0000	.90000	1.0000
2671	3	1.2000	1.0000	1.0000		
401	1	.0				
411	1	.50000E-01				
441	1	1.0000				
571	1	1.0000				
591	1	.0				
601	1	.48730				
621	1	1000.0				
631	1	1.0000				
641	1	4000.0				
651	1	1.0000				
661	1	.0				
681	1	.0				
721	1	1.0000				
741	1	.0				
751	1	.48730				
771	1	40.000				
781	1	2.0000				
791	1	160.00				
801	1	1.0000				
811	1	.0				
831	1	.0				

851	1	.0
871	1	1.0000
881	1	150.00
891	1	.0
901	1	.48730
911	1	[illegible]
921	1	1000.0
941	1	.0
951	1	1000.0
961	1	160.00
971	1	1.0000
981	1	.0
1001	1	.0
1031	1	.0
1041	1	.48730
1061	1	.10000
1071	1	1.0000
1081	1	.40000
1101	1	.0
1131	1	.0
1181	1	4000.0
4140	1	1.0000
4150	1	.0
4160	1	.0
4170	1	.31300
4190	1	.0
4200	1	1000.0
4210	1	1.0300
4220	1	1.0000
4230	1	20.000
4250	1	220.00

WG = 0.900000E+04 WFA = 0.0 WFR = 0.0
WG = 0.900000E+04 WFA = 0.104640E+04 WFR = 0.879777E+03
WG = 0.876196E+04 WFA = 0.925041E+03 WFR = 0.847502E+03

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM b-91

SINGLE ROTOR WINGED HELICOPTER

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 8555. LB

FUSELAGE

LF	LENGTH(BODY+TAILBOOM)	32.3 FT.
LC	LENGTH(CABIN)	6.8 FT.
LB	LENGTH(BODY)	18.7 FT.
LTB	LENGTH(TAILBOOM)	13.7 FT.
XM	FWD. ROTOR LOCATION	11.2 FT.
WF	WIDTH	5.9 FT.
SF	WETTED AREA	462.7 SQ. FT.

WING

AR	ASPECT RATIO	4.50
SW	AREA	82.0 SQ. FT.
BW	SPAN	19.2 FT.
CBARW	MEAN CHORD	4.3 FT.
LAMBDA C/4	QUARTER CHORD SWEEP	0.0 DEG.
LAMBDA	TAPER RATIO	0.600
(T/C)R	ROOT THICKNESS/CHORD	0.170
(T/C)T	TIP THICKNESS/CHORD	0.130
WG/SW	WING LOADING	104.4 LBS/SQ. FT.
GRW	ROTOR/WING GAP	3.7 FT.
CF/C	FLAP CHORD/MEAN CHORD RATIO	0.300

HOR. TAIL

ARHT	ASPECT RATIO	4.000
SHT	AREA	26.5 SQ. FT.
BHT	SPAN	10.3 FT.
CBARHT	MEAN CHORD	2.6 FT.
LAMBDA H	TAPER RATIO	1.000
(T/C)HT	THICKNESS/CHORD	0.150
LTH	HOR. TAIL ARM	19.0 FT.

VERT. TAIL

ARVT	ASPECT RATIO	1.500
SVT	AREA	9.2 SQ. FT.
BVT	SPAN	3.7 FT.
CBARVT	MEAN CHORD	2.5 FT.
LAMBDA VT	TAPER RATIO	0.709
ZTR	TAIL ROTOR(VERT.) LOCATION	3.7 FT.
ZETAVT	TAIL ROTOR/VERT. TAIL OVERLAP RATIO	1.600

(T/C)VT	THICKNESS/CHORD	0.150	

MAIN ROTOR PYLON

AR	ASPECT RATIO	0.218	
SFP	WETTED AREA	6.0	SQ. FT.
FAFP	FRONTAL AREA	1.0	SQ. FT.
HP1	HEIGHT	0.8	FT.
CBARFP	MEAN CHORD	3.6	FT.
LAMBDA FP	TAPER RATIO	0.740	
(T/C)R	ROOT THICKNESS/CHORD	0.450	
(T/C)T	TIP THICKNESS/CHORD	0.250	

PRIMARY ENGINE NACELLE

LN	LENGTH	0.0	FT.
DN	MEAN DIAMETER	0.	FT.
SN	WETTED AREA(TOTAL FOR ALL ENGINES)	0.0	SQ. FT.

AUXILIARY INDEPENDENT ENGINE NACELLE -NO AUXILIARY INDEPENDENT ENGINE USED

PROPELLER(AUXILIARY PROPULSION) - NO PROPELLER USED

MAIN ROTOR

DMR	DIAMETER	38.0	FT.
SIGMR	SOLIDITY	0.066	
WG/A	DISC LOADING	7.5	LB/SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.075	
NR	NO. OF ROTORS	1.	
NO. BLADES	NO. OF BLADES/ROTOR	4.	
THETA	BLADE TWIST	-12.000	DEG.
XC	BLADE CUTOUT/RADIUS RATIO	0.200	
VTIP	TIP SPEED	700.	FT./SEC.

TAIL ROTOR

DTR	DIAMETER	7.4	FT.
SIGTR	SOLIDITY	0.183	
(T/A)NET	NET DISC LOADING	15.1	LB./SQ. FT.
CT/SIGMA	THRUST COEFF./SOLIDITY	0.140	
NO. BLADES	NO. OF BLADES/ROTOR	4.	
THETA	BLADE TWIST	-9.000	DEG.
XCTR	BLADE CUTOUT/RADIUS RATIO	0.050	
G	MAIN/TAIL ROTOR GAP	0.5	FT.
VTIP	TIP SPEED	700.	FT./SEC.

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-91

W E I G H T S D A T A IN LBS

	MLF	MANEUVER LOAD FACTOR	3.000		
	GLF	GUST LOAD FACTOR	1.759		
	ULF	ULTIMATE LOAD FACTOR	4.500		
PROPULSION GROUP					
	WPRG	TOTAL MAIN ROTOR GROUP	683.		
K12	WPRB	MAIN ROTOR BLADE (PER ROTOR)		347.	
K13	WPH	MAIN ROTOR HUB (PER ROTOR)		256.	
	WBF	BLADE FOLDING(PER ROTOR)		0.	
K15	WAR	AUXILIARY PROPULSION ROTOR GROUP	0.		
	WDS	DRIVE SYSTEM	723.		
K16	WPDS	MAIN ROTOR DRIVE SYSTEM		672.	
K28	WTRDS	TAIL ROTOR DRIVE SYSTEM		52.	
K17	WADS	AUXILIARY PROPULSION DRIVE SYSTEM		0.	
K18	WEP	PRIMARY ENGINES	566.		
K19	WEA	AUXILARY ENGINES	0.		
	WPEI	PRIMARY ENGINE INSTALLATION	0.		
	WAEI	AUXILIARY ENGINE INSTALLATION	0.		
	WFS	FUEL SYSTEM	123.		
	DELTA WP	PROPULSION GROUP WEIGHT INCREMENT	100.		
	WP	TOTAL PROPULSION GROUP WEIGHT			2115.
STRUCTURES GROUP					
K8	WW	WING	328.		
	WTG	TAIL GROUP	73.		
K9	WHT	HOR. TAIL		40.	
K14	WTR	TAIL ROTOR		34.	
K6	WB	FUSELAGE	830.		
K7	WLG	LANDING GEAR	218.		
	WNG	NOSE GEAR		44.	
	WMG	MAIN GEAR		175.	
	WTES	TOTAL ENGINE SECTION	125.		
	WPES	PRIMARY ENGINE SECTION		125.	
	WAES	AUXILIARY ENGINE SECTION		0.	
	DELTA WST	STRUCTURE WEIGHT INCREMENT	0.		
	WST	TOTAL STRUCTURE WEIGHT			1542.
FLIGHT CONTROLS GROUP					
	WPFC	PRIMARY FLIGHT CONTROLS	465.		
	WCC	COCKPIT CONTROLS		63.	
K1	WRC	MAIN ROTOR CONTROLS		60.	
K2	WSC	MAIN ROTOR SYSTEMS CONTROLS		139.	
K3	WFW	FIX[illegible] WING CONTROLS		0.	
	WTR	[illegible] MECHANISM		128.	
	WSAS	SAS		75.	
	WAFC	AUXILIARY FLIGHT CONTROLS	0.		
K4	WRCA	AUX. PROPULSION ROTOR CONTROLS		0.	

K5 WSCA	AUX. PROPULSION ROTOR SYS. CONTROLS		0.	
WMC	MISCELLANEOUS CONTROLS		0.	
DELTA WFC	CONTROL WEIGHT INCREMENT	50.		
WFC	TOTAL CONTROL WEIGHT			515.
WFE	WEIGHT OF FIXED EQUIPMENT			1784.
WE	WEIGHT EMPTY			5956.
WFUL	FIXED USEFUL LOAD			1250.
OWE	OPERATING WEIGHT EMPTY			7206.
WPL	PAYLOAD			530.
(WF)A	FUEL			819.
WG	GROSS WEIGHT			8555.

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                                H E S C O M P
           HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    E-91


     R O T O R   D A T A


             ROTOR CYCLE NO.    6.5000

             MAIN ROTOR SOLIDITY SIZED BY MANUEVER CONDITIONS
             H =      2000.0 FT. , TEMP =      70.0 DEG. , V =      180.0 KT.
             100.0 PERCENT HOVER RPM
             ROTOR MANUEVER G'S =  0.700 , CT/SIGMA = 0.075


             TAIL ROTOR SIZED AT      1.000 TIMES THE SOLIDITY
             REQUIRED TO SATISFY HOVERING TURN REQUIREMENTS AT :
                             H                          =     4000.0 FT.
                             TEMP                       =     95.035 DEG..F.
                             CTG/CTNET                  =      1.070
                             YAW RATE                   =      0.0    RAD/SEC.
                             YAW ACCELERATION           =      1.000 RAD/SEC2
                             TAIL ROTOR POLAR
                             MOM. OF INERTIA(PER BLADE) =      0.0    SLUG/FT2
                             HELICOPTER YAW
                             MOM. OF INERTIA            =     7958.0 SLUG/FT2
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                              H E S C O M P
          HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM    B-91


   P R O P U L S I O N   D A T A
          PRIMARY PROPULSION CYCLE NO.    3.110
                 TURBOSHAFT ENGINE

                 1.  ENGINES

              BHP.P          MAX. STANDARD S.L. STATIC H.P.         2031.     H.P.

              ENGINE SIZED FOR TAKEOFF AT T/W =1.05
               95.0 PERCENT MILITARY POWER SETTING,
              H = 4000. FT, TEMPERATURE = 95.04 DEG.F.,
               0.0   ENGINES INOPERATIVE, AND  450.00 FT/MIN VERTICAL RATE OF CLIMB.

              NO CRUISE CONDITION SPECIFIED.


                 MAIN AND TAIL ROTOR DRIVE SYSTEM RATING          1751.     H.P.


                 MAIN ROTOR DRIVE SYSTEM RATING          1548.     H.P.

          XMSN SIZED AT  76. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
          (MAX. STANDARD S.L. STATIC H.P.), 100.0 PERCENT HOVER RPM

                 TAIL ROTOR DRIVE SYSTEM RATING          203.     H.P.

          XMSN SIZED AT  10. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
          (MAX. STANDARD S.L. STATIC H.P.), 100.0 PERCENT HOVER RPM
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SAMPLE CASE NO. 5 PAGE 6

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM 1-91

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A E R O D Y N A M I C S   D A T A
          FE         TOTAL EFFECTIVE FLATPLATE AREA              8.750    SQFT
          SWET       TOTAL WETTED AREA                           659.     SQFT
          CBARF      MEAN SKIN FRICTION COEFF.                   0.013268
       D R A G   B R E A K D O W N          IN  SQFT
          FEW        WING FE                                        0.760
          FEF        FUSELAGE FE                                    7.990
          FEFP       FORWARD(MAIN) ROTOR PYLON FE                   0.0
          FEAP       AFT ROTOR PYLON FE                             0.0
          FEMRH      MAIN ROTOR HUB(S) FE                           0.0
          FETRH      TAIL ROTOR HUB FE                              0.0
          FEVT       VERTICAL TAIL FE                               0.0
          FEHT       HORIZONTAL TAIL FE                             0.0
          FFN        PRIMARY ENGINE NACELLE FE                      0.0
          FENI       AUX. INDEPENDENT CRUISE ENG. NAC. FE           0.0
          FENS       AUX. INDEPENDENT CRUISE ENG. STRUT FE          0.0
          DELTA FE   INCREMENTAL FE                                 0.0
A E R O D Y N A M I C   C O E F F .
          A5                                                    7.98982
          A6                                                    1.03823
          A7                                                    0.16105
          A8                                                    0.00008
          A9                                                    0.24095
          E       WING LIFT EFFICIENCY FACTOR                0.70060
          EVT     VERTICAL TAIL LIFT EFFICIENCY FACTOR       0.88071
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H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM B-91

MISSION PERFORMANCE DATA

TAXI FOR 0.050 HRS. AT GROUND IDLE ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRESS. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	TOTAL FUEL FLOW (LBS/HR)	AUX. TURB. TEMP. (R)	AUX. ENG. CODE	AUX. ENG. PEHF	AUX. ENG. FUEL FLOW (LBS/HR)	TEMP. DEG. (F)
0.0	0.0	0.0	8555.	0.	0.0	1400.0	T	0.0	142.	----	----	----		59.0
0.050	0.0	7.1	8548.	0.	0.0	1400.0	T	0.0	142.	----	----	----		59.0

CLIMB TO 4000. FT. WITH MAXIMUM R/C AT MILITARY ENGINE RATING
** TAS(AND EAS) IS THE HORIZONTAL COMPONENT OF THE FLIGHT PATH SPEED

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	ML	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	BHP	R/C (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST	
CPPRO	CPIND	CPPAR	CPNUO	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CP	CT	CLW	COW	RN	
0.050	0.0	7.1	8548.	0.	76.9	2542.4	Q	1.000	76.9	0.188	0.088	-2.0	26.6	1789.	3947.
700.0	413.	700.0	22.	----	962.	----	----	0.0	----	----	----	----		----	
0.000103	0.000100	0.000038	0.000004	0.01072	0.00021	0.00006	0.000204	A	----	----	----	0.487	0.009	0.904	
0.054	0.33	11.2	8544.	1000.	77.9	2556.2	Q	1.000	76.8	0.190	0.091	-2.0	26.7	1734.	4027.
700.0	414.	700.0	22.	----	954.	----	----	0.0	----	----	----	----		----	
0.000104	0.000105	0.000040	0.000085	0.01082	0.00028	0.00009	0.000210	A	----	----	----	0.487	0.009	0.904	
0.058	0.66	15.1	8540.	2000.	76.9	2570.8	Q	1.000	76.6	0.193	0.094	-2.0	26.7	1748.	4069.
700.0	416.	700.0	22.	----	945.	----	----	0.0	----	----	----	----		----	
0.000106	0.000110	0.000041	0.000005	0.01094	0.00036	0.00013	0.000215	A	----	----	----	0.487	0.009	0.904	
0.062	0.98	19.0	8536.	3000.	79.9	2583.9	Q	1.000	76.5	0.195	0.097	-2.0	26.2	1738.	4033.
700.0	417.	700.0	22.	----	935.	----	----	0.0	----	----	----	----		----	
0.000108	0.000115	0.000043	0.000005	0.01110	0.00047	0.00018	0.000221	A	----	----	----	0.487	0.009	0.905	
0.067	1.32	22.9	8532.	4000.	80.9	2602.5	Q	1.000	76.3	0.198	0.100	-2.0	25.8	1733.	4014.
700.0	420.	700.0	21.	----	927.	----	----	0.0	----	----	----	----		----	
0.000110	0.000121	0.000045	0.000006	0.01131	0.00060	0.00025	0.000226	A	----	----	----	0.487	0.009	0.905	

CRUISE AT NORMAL ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	SPEC. RANGE (NMPP)	BHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCOM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN
0.067	1.32	22.9	8532.	4000.	196.3	2495.0	T	0.876	185.0	0.473	0.050	-18.1	.23413	1523.
700.0	1343.	700.0	115.	----	838.	----	----	0.0	----	----	----	----		----
0.000363	0.000013	0.000515	0.000089	0.02149	0.00264	0.00842	0.001068	A	----	----	----	0.487	0.009	0.457
0.278	41.32	193.7	8361.	4000.	197.2	2495.0	T	0.876	185.9	0.476	0.047	-19.3	.23526	1522.
700.0	1341.	700.0	116.	----	838.	----	----	0.0	----	----	----	----		----
0.000356	0.000011	0.000522	0.000[illegible]09	0.02101	0.00225	0.00834	0.001097	A	----	----	----	0.487	0.009	0.44[illegible]
0.473	81.32	363.7	8191.	4000.	198.1	2495.0	T	0.876	186.7	0.478	0.045	-20.5	.23633	1521.
700.0	1339.	700.0	117.	----	838.	----	----	0.0	----	----	----	----		----
0.000350	0.000010	0.000528	0.000[illegible]08	0.02056	0.00189	0.00825	0.001116	A	----	----	----	0.487	0.009	0.424
0.675	121.32	533.0	8022.	4000.	199.0	2495.0	T	0.876	187.5	0.480	0.042	-21.6	.23734	1520.
790.0	1337.	700.0	118.	----	838.	----	----	0.0	----	----	----	----		----
0.000345	0.000009	0.000534	0.000[illegible]06	0.02015	0.00157	0.03816	0.001114	A	----	----	----	0.487	0.009	0.406
0.819	150.02	653.9	79[illegible]1.	4000.	195.5	2495.0	T	0.876	188.0	0.481	0.043	-22.9	.23801	1521.
700.0	1336.	700.0	119.	----	838.	----	----	0.0	----	----	----	----		----
0.000341	0.000008	0.000535	0.000[illegible]07	0.01967	0.00137	0.00818	0.001119	A	----	----	----	0.487	0.009	0.394

DESCEND TO H = 0. FT. ,R = 160.00 N.MI. AT CONSTANT TAS

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	MU	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	GAMMA (DEG)	RHP	R/S (FPM)
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	BHP AUX	ETAP PROP	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF	AUX. ENG. BHP OR THRUST		
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCOM	CXR	ROTLIM CODE	J	CP	CT	CLW	CDW	RN	
0.819	150.02	653.9	7991.	4000.	150.0	1956.3	P	0.304	141.4	0.362	0.367	-2.7	-3.8	527.	1000.
700.0	459.	760.0	32.	----	396.	----	----	0.0	----	----	----	----		----	
0.000165	0.000030	0.000075	0.000017	0.01394	0.00062	0.00290	0.000207	A	----	----	----	0.487	0.009	0.657	

0.836	152.52	668.5	7894.	3..0.	150.0	1956.1	F	0.304	141.4	0.362	0.067	-2.7	-3.6	526.	10.0.
700.0	459.	700.0	32.	----	396.	----	----	0.0	----	----	----	----		----	
0.000185	0.000030	0.000075	0.000017	0.01393	0.01068	0.00290	0.000208	A	----	----	----	0.487	0.005	0.657	
0.853	155.01	667.1	7888.	2000.	150.0	1956.0	F	0.304	141.4	0.362	0.066	-2.7	-3.6	526.	10.0.
700.0	459.	700.0	32.	----	396.	----	----	0.0	----	----	----	----		----	
0.000185	0.000029	0.000075	0.000017	0.01392	0.01061	0.00289	0.000208	A	----	----	----	0.487	0.009	0.657	
0.869	157.51	673.7	7881.	1000.	150.0	1955.9	F	0.303	141.4	0.362	0.066	-2.7	-3.6	526.	10.0.
700.0	458.	700.0	32.	----	396.	----	----	0.0	----	----	----	----		----	
0.000185	0.000029	0.000075	0.000017	0.01392	0.01060	0.00289	0.000208	A	----	----	----	0.487	0.009	0.657	
0.886	160.00	680.3	7874.	0.	150.0	1955.7	P	0.303	141.4	0.362	0.066	-2.7	-3.8	526.	10.0.
700.0	458.	700.0	32.	----	396.	----	----	0.0	----	----	----	----		----	
0.000185	0.000029	0.000076	0.000017	0.01391	0.01060	0.00289	0.000209	A	----	----	----	0.487	0.00.	.656	

TRANSFER ALTITUDE TO 4000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.886	160.00	680.3	7874.	0.
0.886	160.00	680.3	7874.	4000.

LOITER FOR 0.400 HRS. FOR RESERVE FUEL

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	PRIM. TURB. TEMP. (R)	PRIM. ENG. CODE	PRIM. ENG. PEHF	EAS (KTS)	ML	CT PRIME OVER SIGMA	ALPHA D/L (DEG)	TOTAL FUEL FLOW (LBS/HR)	RHP
M.ROTOR VTIP (FPS)	M.ROTOR RHP	T.ROTOR VTIP (FPS)	T.ROTOR RHP	PROP VTIP (FPS)	PRIM.ENG FUEL FLOW (LBS/HR)	RHP AUX	LTAF PROF	TAUX/T	AUX. ENG. FUEL FLOW (LBS/HR)	AUX. TURB. TEMP.	AUX. ENG. CODE	AUX. ENG. PEHF		AUX. ENG. BHP OR THRUST
CPPRO	CPIND	CPPAR	CPNUD	CDO	DELCDS	DELCDM	CXR	ROTLIM CODE	J	CF	CT	CLW	CDW	RN
0.486	160.00	680.3	7874.	4000.	79.3	1682.6	P	0.251	74.7	0.191	0.092	-2.0	353.	436.
700.0	383.	700.0	20.	----	353.	----	----	0.0	----	----	----	----		----
0.000105	0.000106	0.000040	0.000005	0.01090	0.01031	0.00015	0.000211	A	----	----	----	0.487	0.009	0.914
0.986	160.00	715.3	7839.	4000.	79.3	1681.1	F	0.250	74.7	0.191	0.091	-2.0	349.	434.
700.0	381.	700.0	20.	----	349.	----	----	0.0	----	----	----	----		----
0.000105	0.000105	0.000040	0.000005	0.01088	0.01029	0.00014	0.000211	A	----	----	----	0.487	0.009	0.914
1.086	160.00	750.3	7804.	4000.	79.3	1679.6	F	0.249	74.7	0.191	0.091	-2.0	348.	432.
700.0	379.	700.0	20.	----	348.	----	----	0.0	----	----	----	----		----
0.000105	0.000104	0.000040	0.000005	0.01087	0.01028	0.00014	0.000211	A	----	----	----	0.487	0.009	0.913
1.186	160.00	785.1	7770.	4000.	78.3	1677.9	F	0.248	73.8	0.189	0.091	-2.0	347.	430.
700.0	377.	700.0	20.	----	347.	----	----	0.0	----	----	----	----		----
0.000104	0.000105	0.000039	0.000005	0.01184	0.01026	0.00013	0.000217	A	----	----	----	0.487	0.005	0.915
1.286	160.00	819.9	7735.	4000.	78.3	1676.4	F	0.247	73.8	0.189	0.091	-2.0	347.	42..

700.0	375.	760.0	20.	----	347.	----	----	0.0	----	----	----	----		----
0.060104	7.000104	0.000039	0.000005	7.01083	0.00025	0.00013	0.000266	A	----	----	----	0.487	0.009	0.905

MISSION FUEL REQUIRED = 680.31
RESERVE FUEL REQUIRED = 139.55
TOTAL FUEL REQUIRED = 819.87

SAMPLE CASE NO. 5 PAGE

H E S C O M P
HELICOPTER SIZING & PERFORMANCE COMPUTER PROGRAM b-91

MISSION PERFORMANCE DATA

GROSS WEIGHT = 8555. LB
ALTITUDE = 1000.0 FT.
TEMPERATURE = 55.434 DEG..F.

W/DELTA = 8871. LB
DELTRTH =0.961
DELTA =0.964
THETA =0.993

TAS (KTS) / M.ROTOR VTIP (FPS) / CPPRO / J	MU / M.ROTOR RHP / CPIND / CP (PROP)	CT/SIGMA / T.ROTOR VTIP (FPS) / CPPAR / CT (PROP)	CT / T.ROTOR RHP / CPNUD / CLW	ALPHA D/L (DEG) / PROP VTIP (FPS) / CD / CDW	BHP / RHP AUX / DELCDS / RN	BHPI / ETAP PROP / DELCDM / WING L/D	T/W / TAUX/T / CXR / ROTOR (L/DE)I	FM / TOTAL FUEL FLOW (LBS/HR) / SPEC. RANGE (NMPP) / ROTOR L/DE	FMI / PRIM.ENG FUEL FLOW (LBS/HR) / AUX.ENG FUEL FLOW (LBS/HR) / CONFIG L/DE	EAS (KTS) / PRIM. ENG. PEMF / AUX. ENG. PEMF / AUX. ENG PEMF	SHP/DELRTH	SHPI/DELRTH / M.ROTOR RHP/DELRTH / T.ROTOR RHP/DELRTH / AUX.PROP. RHP/DELRTH
0.0	0.0	0.106	0.0076	-2.0	1158.	0.	1.030	0.739	0.739	0.0	1205.	0.
700.0	917.	700.0	111.	0.0	0.	0.0	0.0	788.	788.	0.668		554.
0.000395	0.000467	0.0	0.0	0.01145	0.0	0.00006	0.0	0.0	0.	0.0		116.
0.0	0.0	0.0	0.313	0.0	1.000	0.0	0.0	0.0	0.0	0.0		0.
20.0	0.048	0.104	0.0065	-0.3	901.	0.	0.0	0.0	0.0	19.7	937.	0.
700.0	783.	700.0	71.	0.0	0.	0.0	0.0	638.	638.	0.519		815.
0.000054	0.000384	0.000002	0.0	0.01123	0.00001	0.00003	0.000035	0.031	0.	0.0		74.
0.0	0.0	0.0	0.313	0.00900	0.996	16.56	0.0	0.67	0.58	0.0		0.
40.0	0.096	0.101	0.0067	-0.6	628.	0.	0.0	0.0	0.0	39.4	653.	0.
700.0	557.	700.0	33.	0.0	0.	0.0	0.0	467.	467.	0.362		579.
0.000093	0.000241	0.000006	0.000001	0.01076	0.00066	0.00000	0.000065	0.086	0.	0.0		34.
0.0	0.0	0.0	0.313	0.00900	0.584	16.56	0.0	1.89	1.67	0.0		0.
60.0	0.145	0.098	0.0065	-1.0	504.	0.	0.0	0.0	0.0	59.1	524.	0.
700.0	446.	700.0	24.	0.0	0.	0.0	0.0	399.	395.	0.290		464.
0.000097	0.000157	0.000017	0.000002	0.01070	0.00018	0.00001	0.000114	0.150	0.	0.0		25.
0.0	0.0	0.0	0.313	0.00900	0.964	16.56	0.0	3.63	3.13	0.0		0.
80.0	0.193	0.095	0.0063	-1.7	476.	0.	0.0	0.0	0.0	78.8	496.	0.
700.0	428.	700.0	22.	0.0	0.	0.0	0.0	386.	386.	0.275		437.
0.000186	0.000111	0.000035	0.000005	0.01093	0.00037	0.00011	0.000183	0.207	0.	0.0		23.
0.0	0.0	0.0	0.313	0.00900	0.937	16.56	0.0	5.42	4.41	0.0		0.

100.0	0.241	0.091	0.0060	-2.6	513.	0.	0.0	0.0	0.0	98.5	533.	0.
700.0	454.	700.0	24.	0.0	0.	0.0	0.0	403.	403.	0.296		472.
0.000121	0.000082	0.000065	0.000009	0.01152	0.00067	0.00042	0.000271	0.248	0.	0.0		25.
0.0	0.0	0.0	0.313	0.00900	0.901	16.56	0.0	6.82	5.12	0.0		0.
120.0	0.289	0.086	0.0057	-3.8	606.	0.	0.0	0.0	0.0	118.3	631.	0.
700.0	540.	700.0	28.	0.0	0.	0.0	0.0	453.	453.	0.350		562.
0.000145	0.000062	0.000113	0.000014	0.01263	0.00112	0.00106	0.000379	0.265	0.	0.0		29.
0.0	0.0	0.0	0.313	0.00900	0.858	16.56	0.0	7.48	5.20	0.0		0.
140.0	0.338	0.081	0.0054	-5.4	761.	0.	0.0	0.0	0.0	138.0	792.	0.
700.0	683.	700.0	37.	0.0	0.	0.0	0.0	553.	553.	0.439		718.
0.000161	0.000047	0.000171	0.000019	0.01433	0.00176	0.00215	0.000506	0.253	0.	0.0		36.
0.0	0.0	0.0	0.313	0.00900	0.806	16.56	0.0	7.35	4.83	0.0		0.
160.0	0.386	0.075	0.0050	-7.5	985.	0.	0.0	0.0	0.0	157.7	1025.	0.
700.0	886.	700.0	53.	0.0	0.	0.0	0.0	688.	688.	0.568		922.
0.000236	0.000035	0.000252	0.000020	0.01685	0.00265	0.00378	0.000653	0.233	0.	0.0		52.
0.0	0.0	0.0	0.313	0.00900	0.747	16.56	0.0	6.62	4.26	0.0		0.
180.0	0.434	0.068	0.0045	-10.2	1298.	0.	0.0	0.0	0.0	177.4	1342.	0.
700.0	1158.	700.0	73.	0.0	0.	0.0	0.0	812.	812.	0.744		1205.
0.000315	0.000026	0.000356	0.000013	0.02032	0.00387	0.00603	0.000819	0.222	0.	0.0		76.
0.0	0.0	0.0	0.313	0.00900	0.680	16.56	0.0	5.57	3.66	0.0		0.
200.0	0.482	0.061	0.0040	-14.0	1747.	0.	0.0	0.0	0.0	197.1	1817.	0.
700.0	1539.	700.0	136.	0.0	0.	0.0	0.0	953.	953.	1.007		1682.
0.000428	0.000019	0.000485	0.000011	0.02489	0.00551	0.00896	0.001006	0.210	0.	0.0		141.
0.0	0.0	0.0	0.313	0.00900	0.605	16.56	0.0	4.25	3.01	0.0		0.
220.0	0.531	0.053	0.0035	-19.2	2479.	0.	0.0	0.0	0.0	216.8	2579.	0.
700.0	2643.	700.0	342.	0.0	0.	0.0	0.0	1320.	1320.	1.429		2126.
0.000587	0.000013	0.000643	0.000010	0.03074	0.00771	0.01201	0.001211	0.167	0.	0.0		355.
0.0	0.0	0.0	0.313	0.00900	0.522	16.56	0.0	3.03	2.33	0.0		0.

MAIN TRANSMISSION TORQUE LIMIT (ALL ENGINES OPERATING) OCCURS AT

V	=	199.8 KTAS
MAIN ROTOR VTIP	=	700.0 FT/SEC
MAIN ROTOR RPM	=	351.8
POWER	=	1599. SHP
TORQUE	=	23872. FT-LB

ROTOR LIMITS NOT APPLIED

V(MAX PWR)	=	199.8 KTAS	SPEC.RANGE	=	0.210 NM/LB	Q
V(MIL PWR)	=	199.8 KTAS	SPEC.RANGE	=	0.210 NM/LB	Q
V(NRP)	=	192.4 KTAS	SPEC.RANGE	=	0.215 NM/LB	T
V(BEST RANGE)	=	178.6 KTAS	SPEC.RANGE	=	0.221 NM/LB	P
V(99 PERCENT BR)	=	172.1 KTAS	SPEC.RANGE	=	0.219 NM/LB	P
V(BEST ENDURANCE)	=	79.6 KTAS	FUEL FLOW	=	386. LB/HR	P

END OF SUCCESSFUL CASE

REFERENCES

1. Schoen, A. H. and Wisniewski, J. S., User's Manual for VASCOMP II, THE V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM, Boeing Vertol Company, Report D8-0375, Volume VI, Rev. 2, September 1973.

2. Low, E. M. II, SHORTCUT PERFORMANCE METHODOLOGY, Boeing Vertol Company, IOM 8-7444-1-119, 22 October 1969.

3. Low, E. M. II, WATFOR PROGRAMS FOR PERFORMANCE DETERMINATION, Boeing Vertol Company, IOM 8-7444-1-188, 18 August 1971.

4. Mills, S., INCORPORATION OF ROTOR-ROTOR INTERFERENCE DATA FROM UHM TESTS INTO SHORTCUT METHODOLOGY, Boeing Vertol Company, IOM 8-7444-1-173, 9 March 1971.

5. Lynn, R. R., et al, TAIL ROTOR DESIGN, Part I - Aerodynamics, AHS Journal, Volume 15, No. 4, October 1970.

6. Weisner, W. and Kohler, G., DESIGN GUIDELINES FOR TAIL ROTORS, Boeing Vertol Company, Report D210-10687-1, September 1973.

7. Gabriel, E. A., DRAG ESTIMATION OF V/STOL AIRCRAFT Boeing Vertol Company, Report D8-2194-1, July 1969.

8. Julian, D., HLH HUB DRAG REVIEW, Boeing Vertol Company, IOM 8-7444-1-200, 26 April 1972.

9. MIL-C-5011A, Military Specification: STANDARD AIRCRAFT CHARACTERISTICS AND PERFORMANCE CHARTS, PILOTED AIRCRAFT, November 5, 1961.

10. Borst, H. V., A SHORT METHOD TO PROPELLER PERFORMANCE, Curtiss-Wright Corporation, Propeller Division.

11. Federal Aviation Regulations, Part 25, AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES, Federal Aviation Agency, Washington, D.C.

12. Livingston, C. L. and Murphy, M. R., FLYING QUALITIES CONSIDERATIONS IN THE DESIGN AND DEVELOPMENT OF THE HUEY COBRA, AHS Journal, Vol. 14, #1, January 1969.

13. Brown, E. L. and Schmidt, P. S., THE EFFECT OF HELICOPTER PITCHING VELOCITY ON ROTOR LIFT CAPABILITY, AHS Journal, Vol. 8, #4, October 1963.

14. Drees, J. M. and McGuigan, M. J., HIGH SPEED HELICOPTERS AND COMPOUNDS IN MANEUVERS AND GUSTS, Proceedings of 21st Annual National Forum of AHS, May 1965.

15. Drees, J. M., ANALYTICAL STUDY OF HELICOPTER GUST RESPONSE AND HIGH FORWARD SPEEDS, AAVLABS TR69-1, September 1969.

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